

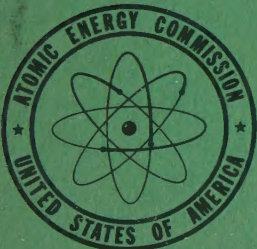
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UNITED STATES ATOMIC ENERGY COMMISSION

# Nuclear Science Abstracts

Vol. 6 No. 1

Abstracts 1-488

Jan. 15, 1952



Technical Information Service, Oak Ridge, Tennessee



Nuclear Science Abstracts is issued twice monthly throughout the calendar year by the Atomic Energy Commission. It is intended primarily to serve scientists and engineers working within the Atomic Energy Project by abstracting as completely and as promptly as possible the literature of nuclear science and engineering. It covers not only the unclassified and declassified research reports of the Atomic Energy Commission and its contractors, but also material in its field of interest which appears in technical and scientific journals and unpublished research reports of government agencies, universities, and industrial research establishments. The final issue (December 30) each year lists the domestic and foreign journals from which articles have been abstracted in Nuclear Science Abstracts.

#### Indexes

Volumes 1, 2, 3, and 4 of Nuclear Science Abstracts are cumulatively indexed by Author, Subject, and Nuclide in Volume 4, No. 24B, Dec. 30, 1950. The Author, Subject, and Nuclide indexes for Volume 5 of NSA appear in Volume 5, No. 24, Dec. 31, 1951. The cumulative Numerical Index of AEC Reports, described on the inside back cover, is published in Volume 5, No. 24, and includes all reports abstracted in the first five volumes of Nuclear Science Abstracts as well as those abstracted in Abstracts of Declassified Documents.

Each issue of Volume 6(1952) contains an Author Index and a current supplement to the cumulative Numerical Index of Reports. Subject and Author Indexes, cumulated quarterly, are issued as separate supplements to the sixth, twelfth, and eighteenth issues. The 24th issue will be the Cumulative Index for the year.

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Announcement of the U. S. Atomic Energy Commission  
OAK RIDGE SCHOOL OF REACTOR TECHNOLOGY  
INVITES INDUSTRY TO SPONSOR STUDENTS FOR  
1952-53 TERM BEGINNING IN SEPTEMBER

Industrial organizations interested in obtaining special training in nuclear reactor technology for experienced engineers in their employ are invited to sponsor their enrollment in the 1952-53 session of the Oak Ridge School of Reactor Technology. The deadline for experienced engineer applicants is March 1, and the school term begins September 8, 1952.

Established in 1949 at the Oak Ridge National Laboratory, the school operates a twelve-month session open to two categories of engineering candidates. A limited number of recent college graduates are accepted in Category A in the status of student employees. Category B students are selected from the applications sponsored by Government agencies and private industrial firms interested in participating in the AEC nuclear energy program. Such firms need not be connected with the AEC currently.

Officials of the Oak Ridge Reactor School point out that the majority of problems encountered in the fields of nuclear engineering involve the same fundamental engineering and management skills common to industry generally. This school offers an excellent opportunity for experienced engineers to obtain the specialized training they need to apply their skills effectively in the nuclear engineering field. Trainees remain on the payroll of their home organizations, and upon returning after completion of the course, can be expected to help strengthen their companies' position to participate in the national atomic energy program.

To accommodate the enlarged student enrollment for the class currently in session, the faculty and staff were increased and a new student laboratory was constructed recently.

Further information and application forms may be obtained by writing to the Director, Oak Ridge School of Reactor Technology, P. O. Box P, Oak Ridge, Tennessee.

Since much of the material presented in the curriculum of the Oak Ridge School of Reactor Technology is classified, all enrollments are contingent upon a personal security investigation. Announcements of appointments will be made on or before April 1.







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## ERRATUM

NSA, Vol. 5, No. 18. In abstract 4851, Co<sup>50</sup> in the second reaction should be Co<sup>59</sup>.



# REPORTS REFERENCE LIST

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PRE-PROTECTION OF MICE AGAINST X-IRRADIATION MORTALITY BY SODIUM NITRITE (Technical Objective AW-6); by L. J. Cole, V. P. Bond, and M. C. Fishler. Sept. 21, 1951. 14p. (AD-331(B))		PLASTIC DEFORMATION OF URANIUM; by R. W. Cahn. July, 1951. 56p. (AERE-M/R-740)	
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Atomic Energy Research Establishment, Harwell, Berks (England)		Atomic Energy Research Establishment, Harwell, Berks (England)	
CHARACTERIZATION OF IMPURITIES IN BORON TRIFLUORIDE BY INFRA-RED ABSORPTION SPECTRA; by J. Gaunt. Oct. 11, 1951. 5p. (AERE-C/M-124)		INFLUENCE OF A CYLINDRICAL CHANNEL ON A PERIODIC NEUTRON DENSITY DISTRIBUTION; by B. Davison. [nd] 22p. (AERE-T/R-738)	
AERE-C/R-699	135	AF-TR-6080	200*
Atomic Energy Research Establishment, Harwell, Berks (England)		Pennsylvania State Coll.	
A FURNACE FOR THE STUDY OF CHEMICAL REACTIONS BETWEEN GASES AND SOLIDS IN THE HARWELL PILE; by M. Tomlinson and J. Wright. Apr. 9, 1951. 13p. (AERE-C/R-699)		REFRACTORY MATERIALS FOR USE IN HIGH-TEMPERATURE AREAS OF AIRCRAFT (Summary Report); by N. R. Thielke and E. C. Henry. July 1950. 51p. (AF-TR-6080)	
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Atomic Energy Research Establishment Harwell, Berks (England)		Army Medical Research Lab., Fort Knox	
SEARCH FOR <sup>7</sup> Be IN URANIUM FISSION; by G. B. Cook. July 11, 1951. 3p. (AERE-C/R-758)		AN AID TO ACCURACY IN ROENTGENOGRAPHY; by Arthur Carpenter. Sept. 3, 1951. 14p. (AMRL-62)	
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SOME PRELIMINARY OBSERVATIONS ON THE RAMAN SPECTRA OF URANYL SALTS; by J. Sutton. Aug. 31, 1951. 13p. (AERE-C/R-769)		THYROID RESPONSE TO TOTAL-BODY X-IRRADIATION; by A. L. Botkin, E. H. Praytor, Mary E. Austing, and J. Hensen. Sept. 28, 1951. 9p. (AMRL-66)	
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THE EFFECT OF SURFACE TREATMENT ON ELECTRIC BREAKDOWN BETWEEN COPPER ELECTRODES AT 50 CYCLES AT VERY LOW PRESSURES; by R. J. B. Hadden. Aug. 1951. 14p. (AERE-G/M-92)		DECOMPOSITION TEMPERATURES OF POLYTETRAFLUOROETHYLENE AND POLYMONOCHLOROTRIFLUOROETHYLENE AS INDICATED BY HALOGEN LIBERATION; by H. A. Watson, H. J. Stark, L. E. Sieffert, and L. B. Berger. Dec. 1950. 12p. (BM-RI-4756)	
AERE-I/R-777	151	EES-2A101734	203*
Atomic Energy Research Establishment, Harwell, Berks (England)		Naval Engineering Experiment Station, Annapolis	
THE PRODUCTION OF IODINE <sup>131</sup> FROM PILE IRRADIATED TELLURIUM AT ABOUT THE CURIE LEVEL OF ACTIVITY; by W. J. Arrol. Sept., 11, 1951. 2p. (AERE-I/R-777)		TEST OF PFAUDLER COMPANY CERAMIC COATING FOR WET EXHAUST MUFFLERS AND PIPING; by Alan R. Schrader. Nov. 3, 1950. 20p. (EES-2A101734; U-16633)	
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Atomic Energy Research Establishment, Harwell, Berks (England)		Naval Engineering Experiment Station, Annapolis	
A LABORATORY RESISTANCE WELDING UNIT; by R. D. Semmens. Aug. 22, 1951. 10p. (AERE-M/R-739)		REPORT OF AN INVESTIGATION ON WATER AND STEAM LUBRICATED BEARINGS; by William J. Vitellozzi. June 9, 1950. 24p. (EES-C-3229-C)	
		F-TR-2250-1A	274*
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		THERMODYNAMIC FUNCTIONS OF HALOGENS AND HYDROGEN HALIDES; by Rudolph Edse. Nov. 1949. 51p. (F-TR-2250-1A; ATI-43532)	

- NBS-1146** 295  
National Bureau of Standards  
ANNUAL REPORT ON RADIATION SENSITIVITY OF PHOTOGRAPHIC EMULSIONS; COVERING THE FISCAL YEAR JULY 1, 1950, TO JULY 1, 1951; by Margarete Ehrlich. [nd] 5p. (NBS-1146)
- NP-1900** 32  
Naval Medical Research Station, Joint Task Force One  
A COMPARISON OF THE EFFECTS OF TEST ABLE ATOMIC BOMB IONIZING RADIATION AND X-RAYS ON SEEDS OF BARLEY, WHEAT, AND OATS; APPENDIX No. 25 TO THE FINAL REPORT; by Luther Smith. [nd] 17p. (NP-1900)
- NP-3092** 210\*  
National Academy of Sciences  
MINUTES OF THE SYMPOSIUM ON CORROSION; FEBRUARY 3 AND 4, 1949; Julius J. Harwood, Chairman. [nd] 174p. (NP-3092)
- NP-3112** 229  
Towne Scientific School, Univ. of Pennsylvania  
PREPARATION OF SINGLE CRYSTALS OF BERYLLIUM AND ZIRCONIUM; A STUDY OF MECHANICAL PROPERTIES QUARTERLY REPORT; JANUARY 1, 1951, TO APRIL 1, 1951; by R. M. Brick, H. T. Lee, and H. Greenwald. [nd] 7p. (NP-3112)
- NP-3142** 444  
Norman Bridge Lab. of Physics, Calif. Inst. of Tech.  
FUNDAMENTAL RESEARCH IN SPECTROSCOPY OF SHORT WAVE-LENGTH X-RAYS AND GAMMA-RAYS; SIXTEENTH QUARTERLY REPORT; PERIOD JANUARY 1st TO MARCH 31, 1951; by Jesse W. M. DuMond. 14p. [nd] (NP-3142)
- NP-3173** 296  
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- NP-3189** 445  
Southern California Univ.  
ISOTOPE SHIFT IN THE ATOMIC SPECTRUM OF CARBON AND NITROGEN (Technical Report No. 1); by John R. Holmes. Feb. 1, 1950. 24p. (NP-3189)
- NP-3243** 199  
Alfred Univ.  
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- NP-3262** 446  
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- NP-3310** 87  
Southern Calif. Univ.  
A STUDY OF THE EXCHANGE OF RADIOCYANIDE AND RADIOSULFIDE IONS WITH AQUEOUS THIOCYANATE ION; by Arthur M. Adamson and Philip S. Magee. [nd] 6p. (NP-3310)
- NP-3456** 116  
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RECRYSTALLIZATION AND MELTING OF SIMPLE CRYSTALS; OFFICE OF NAVAL RESEARCH (Technical Reports Nos. 36, 37, 38); by W. A. Weyl and D. P. Enright. Aug. 1951. 76p. (NP-3456)
- NP-3456(Report No. 36)** 117  
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THE MECHANISM OF RECRYSTALLIZATION AND OF SINTERING, Report No. 36 of RECRYSTALLIZATION AND MELTING OF SIMPLE CRYSTALS; OFFICE OF NAVAL RESEARCH TECHNICAL REPORTS NOS. 36, 37, 38; by W. A. Weyl and D. P. Enright. Aug. 1951. (NP-3456 (Report No. 36))
- NP-3456(Report No. 37)** 118  
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ATOMISTIC APPROACH TO THE MELTING OF SIMPLE IONIC CRYSTALS; by W. A. Weyl, Report No. 37 of RECRYSTALLIZATION AND MELTING OF SIMPLE CRYSTALS; OFFICE OF NAVAL RESEARCH TECHNICAL REPORTS NOS. 36, 37, 38, by W. A. Weyl and D. P. Enright. Aug. 1951. (NP-3456 (Report No. 37))
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ATOMISTIC APPROACH TO THE FORMATION OF EUTECTICS BETWEEN SIMPLE BINARY COMPOUNDS; by W. A. Weyl (Report No. 38 of RECRYSTALLIZATION AND MELTING OF SIMPLE CRYSTALS; OFFICE OF NAVAL RESEARCH TECHNICAL REPORTS NOS. 36, 37, 38 by W. A. Weyl and D. P. Enright). Aug. 1951. (NP-3456(Report No. 38))
- NP-3466** 183\*  
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HYDRAULIC JETS AT LOW REYNOLDS NUMBER AND CONSTANT WEBER NUMBER (Medical Laboratories Research Report No. 64); by G. M. Asset and P. D. Bales. June 1951. 21p. (NP-3466)
- NP-3469** 230  
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SOME CRYSTALLOGRAPHY PHENOMENA ASSOCIATED WITH GRAIN GROWTH IN COPPER; by M. Sharp and C. G. Dunn. Sept. 26, 1951. 8p. (NP-3469; 50TP120-1)
- NP-3470** 377  
Massachusetts Inst. of Tech. Research Lab. of Electronics  
DETERMINATION OF AXIAL FIELD STRENGTH IN A LINEAR ACCELERATOR CAVITY (Technical Report No. 205); by L. C. Maier, Jr., and J. C. Slater. May 31, 1951. 6p. (NP-3470)



- NP-3472 253  
Research Lab. of Electronics, Mass. Inst. of Tech.  
ELECTROMAGNETIC RESONANT BEHAVIOR OF A CONFOCAL SPHEROIDAL CAVITY SYSTEM IN THE MICRO-WAVE REGION (Technical Report No. 206); by J. C. Simons and J. C. Slater. May 31, 1951. 4p. (NP-3472)
- NP-3473 166\*  
Metalloy Corp.  
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- NP-3474 231  
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THE EFFECT OF ALLOYING ELEMENTS ON THE ELEVATED TEMPERATURE PLASTIC PROPERTIES OF ALPHA SOLID SOLUTIONS OF ALUMINUM (Eleventh Technical Report); by O. D. Sherby, R. A. Anderson, and J. E. Dorn. Dec. 15, 1950. 73p. (NP-3474; U-15651)
- NP-3477 120  
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- NP-3478 184  
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DYNAMICS OF PARTICULATE MATTER IN FLUID SUSPENSIONS (Final Report); by Vito A. Vanoni, En-Yun Hsu, and R. W. Davies. Nov. 1950. 29p. (NP-3478; U-17317)
- NP-3479 59\*  
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- NP-3480 403  
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A SIMPLE FLASH X-RAY CIRCUIT; FOURTH REPORT ON MISCELLANEOUS EFFECTS; OCTOBER 1950 - MARCH 1951; by R. O. Fleming, Jr. Issued Mar. 23, 1951. 26p. (NP-3480; U-17300; Memo Report No. 16)
- NP-3481 232  
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- NP-3482 136  
Gates and Crellin Labs. of Chemistry, Calif. Inst. of Tech.  
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- NP-3483 108\*  
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- NP-3486 286  
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- NP-3491 233  
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- NP-3492 109  
Department of Mines and Technical Surveys (Canada)  
THE DETERMINATION OF NaOH IN THE PRESENCE OF LARGE QUANTITIES OF Na<sub>2</sub>CO<sub>3</sub> USING pH TO DETERMINE THE END POINT (Topical Report No. TR-91/51); by H. J. Herbst. Oct. 4, 1951. 4p. (NP-3492)
- NP-3493 407  
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- NP-3498 88  
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VAPOR PRESSURES OF INORGANIC SUBSTANCES; VIII. MOLYBDENUM BETWEEN 2151°K AND 2462°K; by James W. Edwards, Herrick L. Johnston, and Paul E. Blackburn. Oct. 29, 1951. 9p. (NP-3498; TR-281-12)
- NRL-3879 89  
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THE PREPARATION OF HIGH PURITY SILVER CHLORIDE AND SILVER BROMIDE; by William Zimmerman, III. Oct. 24, 1951. 7p. (NRL-3879)

ONRL-62-51 448\*  
Office of Naval Research, London  
MOLECULAR SPECTROSCOPY CONFERENCE IN BASEL;  
June 28 - 30, 1951; by George J. Szasz. July 20, 1951. 17p.  
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Research and Development Board  
SYMPOSIUM ON TITANIUM; 8 AND 9 NOVEMBER 1950.  
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Geological Survey  
VEIN DEPOSITS OF URANIUM AT THE CARIBOU MINE,  
BOULDER COUNTY, COLORADO; by Robert U. King. [nd]  
17p. (TEM-13A)

TEM-24A 214  
Geological Survey  
TORBERNITE OCCURRENCE AT THE ROBINEAU  
CLAIMS, CLEAR CREEK COUNTY, COLORADO; by Robert  
U. King and Harry C. Granger. [nd] 5p. (TEM-24A)



## GENERAL

### RESEARCH PROGRAMS

1

Oak Ridge National Lab.

QUARTERLY PROGRESS REPORT FOR PERIOD ENDING JULY 20, 1951; HEALTH PHYSICS DIVISION; K. Z. Morgan, Director. Issued Nov. 23, 1951. 26p. (ORNL-1086)

Brief statements are made on the following phases of the work of the Health Physics Division: the operation of constant-flow water monitor, survey studies and ecological study of White Oak Creek drainage system, operation of fast-neutron pocket chambers, measurement of radiation by frequency variations of an r-f oscillator, design of a thermal-neutron survey meter, results of calculation of the air scattering of neutrons, design of x-ray control equipment, and the use of commercially available G-M survey equipment with light aircraft to locate contaminated areas.

## BIOLOGY AND MEDICINE

2

Oak Ridge National Lab.

A CASE OF MALE STERILITY IN MAIZE INVOLVING GENE-CYTOPLASM INTERACTION (abstract); by Drew Schwartz. [nd] 1p. (AECU-1687)

The report is reproduced here in its entirety.

The inheritance of a male-sterile condition in maize was found to be conditioned by an interaction of three factors: (1) a dominant gene for male sterility ( $Ms_{21}$ ), (2) a dominant suppressor of sterility ( $S^{Ga}$ ) associated with a male gametophyte effect, and (3) a specific "sterile" cytoplasm ( $\square$ ) essential for the expression of male sterility. Male sterile plants are of the constitution -  $\square Ms ms s^{Ga} s^{Ga}$ . Plants which either lack the dominant sterility gene, carry the dominant suppressor, or possess the nonsterile cytoplasm are male fertile. Due to complete selective fertilization, the suppressor gene segregates only when the heterozygote,  $S^{Ga} s^{Ga}$  is used as the pistillate parent. The inbred line Kys is homozygous recessive for  $ms$  and  $s^{Ga}$ . All other unrelated lines studied were found to be  $Ms Ms S^{Ga} S^{Ga}$ . (Paper presented at Genetic Society of America, Sept. 1951, Minneapolis)

3

Oak Ridge National Lab.

PHOSPHATASE ACTIVITY OF LILY ANTHERS (abstract); by G. R. Noggle. [nd] 1p. (AECU-1692)

The report is reproduced here in its entirety.

Phosphatase activity was determined at different stages of development of lily anthers. Preliminary studies indicated that the maximum phosphatase activity was found between pH 4.5 and pH 5.0. All subsequent determinations were run in the presence of an acetate buffer at pH 5.0.

Sodium  $\beta$ -glycerophosphate, adenylic acid, yeast nucleic acid, and sodium pyrophosphate were used as substrates. The phosphatase activity was highest during the early stages of anther development when the sporogenous tissue was undergoing mitosis but decreased until the time of divisions I and II. There then followed an increase in phosphatase activity coinciding with the time of tetrad formation. The phosphatase activity then decreased as the pollen grains matured. (Paper presented at Botanical Society of America, Sept. 1951, Minneapolis)

4

Oak Ridge National Lab.

THE INDUCTION OF CHROMOSOMAL ABERRATIONS BY OXYGEN (abstract); by Alan D. Conger and L. M. Fairchild. [nd] 1p. (AECU-1697)

The report is reproduced here in its entirety.

Treatment of dry pollen grains of the plant *Tradescantia* with oxygen (greater than 99.5% pure) produces chromosomal aberrations which can be observed at the pollen tube division on pollen culture slides. The aberrations produced are identical with those found after irradiation with x or  $\gamma$  rays. Pollen treated with oxygen from two different cylinders (evacuated 5 times, gas flushed 5 times) and pollen merely flushed with oxygen, all had aberration frequencies equivalent to that produced by about 600 r of x rays in air. Control pollen (not evacuated) and air pollen (evacuated 5 times, air flushed 5 times) had almost no aberrations. Exposure of oxygen-treated pollen to but 2 r of  $\gamma$  rays caused so many chromosomal breaks that an analysis could be made of fragment frequency only. The fragment frequency was higher than oxygen alone, and roughly about what would be

expected from 1000 r of  $\gamma$  rays in air. (Paper presented at Genetic Society of America, Sept. 1951, Minneapolis)

5

Tennessee Univ. and Oak Ridge National Lab.  
CHANGES IN THE PHYSICAL NATURE OF THE MITOTIC SPINDLE DURING CELL DIVISION (abstract); by J. Gordon Carlson. 1p. (AECU-1706)

The report is reproduced here in its entirety.

Microdissection studies of living neuroblast of the grasshopper, *Chortaphaga viridifasciata*, indicate that the mitotic spindle at metaphase is a semisolid body situated in a cytoplasm of low viscosity. Its structural components are oriented longitudinally. It is developed during prometaphase from the fluid material of the nucleus. During anaphase the portion of the spindle between the separating groups of daughter chromosomes liquefies progressively as the chromosomes move to the poles, leaving in the interzonal region only highly fluid protoplasm and the interzonal fibers that connect the distal ends of sister chromosomes. (auth)

5

Johns Hopkins Univ.  
THE THEORY OF RATE PROCESSES AND GENE MUTATION; by W. D. McElroy and C. P. Swanson. [nd] 42p. (AECU-1713)

Genetic changes are pictured as being initiated by a chemical mutagen, which may be naturally occurring, radiation-induced, or artificially applied, and which in combination with a particular group in the genic structure initiates a series of reactions which give rise to an intermediate semi-activated state. This state may lead to a permanent change in the genic structure or it may, after a period of time, revert to a normal state. Environmental circumstances affecting the probability of the change's going one way or the other are discussed. The theory of absolute reaction rates as applied to gene mutation is reviewed and reevaluated. Energy levels necessary for a molecule to reach the activated state are considered. Reaction rate and factors affecting frequency of mutations are illustrated with reports of experimental work by the authors using plants. The potentiating effect of infrared radiation on changes induced by x rays, and changes produced by pressure and temperature on the mutagenic effects of nitrogen mustard are reviewed.

7

Medical Clinic, Peter Bent Brigham Hospital  
THE EFFECT OF ACTH UPON GASTRIC SECRETION; by Seymour J. Gray, John A. Benson, Jr., Robert W. Reifenstein, and Howard H. Spiro; Medical Clinic, Peter Bent Brigham Hospital and Biophysical Lab., Harvard Medical School. [nd] 13p. (AECU-1715)

ACTH in doses of 100 to 160 mg administered intramuscularly daily for periods of 3 to 4 weeks to patients with normal stomachs produced an increase in gastric secretion of HCl and pepsin and a rise in the urinary uropepsin excretion. In every case these values were increased to the levels usually observed in patients with peptic ulcers. Mediation of the hormonal phase of gastric secretion by adrenal corticoids and the site of action of the corticoids are discussed.

5

Long Island Biological Assn., Cold Spring Harbor  
AUTOSOMAL LETHALS IN EXPERIMENTAL POPULATIONS OF *DROSOPHILA MELANOGASTER*; by Bruce Wallace. [nd] 6p. (AECU-1716)

Preliminary work indicating that a large proportion of induced lethals in the second chromosome of *D. melanogaster* are incompletely recessive is reported. Three experimental populations of *D. melanogaster* were analyzed

for lethal second chromosomes. The original flies of two of these populations were treated with x rays. Frequencies of lethals in experimental populations is presented in tabular form. Data indicate that less than one-half of the original induced lethals persist through six generations.

9

Medical Clinic, Peter Bent Brigham Hospital  
THE EFFECT OF ADRENOCORTICOTROPIC HORMONE UPON THE FECAL LYSOZYME TITER IN ULCERATIVE COLITIS; by Robert W. Reifenstein and Seymour J. Gray; Medical Clinic, Peter Bent Brigham Hospital and Biophysical Lab., Harvard Medical School. [nd] 20p. (AECU-1719)

Viscosimetric determination of serial fecal lysozyme titers were correlated with clinical activity in a study of the effect of adrenocorticotrophic hormone upon the fecal lysozyme titer in ulcerative colitis. Fecal lysozyme activity of normal subjects averaged 5.1 units/g, while in the acute phase of ulcerative colitis lysozyme titer increased to a mean of 100.3 units/g. Repeated exacerbations and remissions in the disease were paralleled by increase and decrease in the fecal lysozyme titer. Administration of ACTH resulted in a remission of the acute phase of the disease and produced a significant and often dramatic fall in the lysozyme titer which accompanied remission. This ACTH effect was considered to represent an altered tissue reaction to injury.

10

Institute of Radiobiology and Biophysics, Univ. of Chicago  
THE EFFECT OF PLOIDY IN PHOTOREACTIVATION; by S. D. Warshaw. [nd] 11p. (AECU-1720)

Survival data of the diploid and haploid strains of the yeast *Saccharomyces cerevisiae* following ultraviolet irradiation both with and without subsequent photoreactivation, are presented.

11

Tennessee Valley Authority  
THE FIRST SPRING ESTIMATE OF THE SIZE OF THE FISH POPULATION OF WHITE OAK LAKE; MARCH-APRIL 1951; by Louis A. Krumholz. [nd] 18p. (ORO-51)

12

Atomic Energy Project, Univ. of Calif., Los Angeles  
SOME EFFECTS OF AIR BLAST ON MECHANICALLY CONSTRAINED MICE; by Benedict Cassen, Katherine Kistler, and Wanda Mankiewicz. Oct. 25, 1951. 18p. (UCLA-166)

Mice were exposed to high explosive blasts while loosely held by their feet on rigid plates, in field tests or in laboratory blast tube tests. The animals so mounted were killed at not much over half the shock pressure that would kill them while unconstrained. Lethality was always associated with dyspnea and with heavy edematous lungs. Wet lung weights and hemorrhage effects are charted in relation to blast pressure and distance of blasts. Shielding and vasoconstriction experiments indicate that the lung edema is caused by central nervous injury.

13

Atomic Energy Project, Univ. of Calif., Los Angeles  
GASTRO-INTESTINAL TRANSIT; by R. D. Goodman, A. E. Lewis, E. A. Schuck, and M. A. Greenfield. Issued Nov. 15, 1951. 13p. (UCLA-167)

A new concept of gastrointestinal transit is presented with an experimental procedure for its measurement in rats. Gastrointestinal transit is defined as the fraction of the quantity of material contained in a given segment which is delivered to its adjacent distal segment per unit of time. The experimental procedure consists in the administration of a nonabsorbable dye [Evans blue] into the stomach with subsequent time analyses of the gastrointestinal segments



for their quantitative dye content. The relationship of transit to small intestinal absorption is discussed, and an objective method for the measurement of absorption availability is described. The kinetics of transit are expressed mathematically and the parameters of the descriptive equations are calculated. Whereas previous physiological studies on gastrointestinal motor activity have examined the behavior of segmental contractions and have noted the qualitative aspects of propulsion, this investigation describes a method for measuring quantitatively the net propulsive effect and, at the same time, reveals the role played by each major gastrointestinal segment in achieving this effect. An application of this method is given in report UCLA-168. (auth)

14  
Radiation Lab., Univ. of Calif.  
GRANA-LIKE STRUCTURES OF *SYNECHOCOCCUS CEDORUM*; by M. Calvin and V. Lynch. Oct. 23, 1951. 7p. (UCRL-1502)

Spectrographic analysis of fractionated cells of the blue-green algae *Synechococcus cedorum* shows two groups of pigments, chlorophyll and carotenoids, are associated with particles considered analogous to the grana of other green plants, while the phycocyanin is in solution. Electron micrographs of the whole cells and of the sediment obtained after fractionation substantiate these findings.

15  
ROUTIN—ITS EFFECT ON THE EOSINOPHIL COUNT IN THE PERIPHERAL BLOOD OF NORMAL SUBJECTS.

James Dougherty and John K. Meneely, Jr. *J. Lab. Clin. Med.* 38, 709-11(1951).

A modification of the (Thorn) eosinophil test is offered as a means of determining the adrenal-stimulating effect of rutin. Oral and parenteral administration of rutin (Abbott) in therapeutic doses did not exercise an adrenal cortical stimulating effect.

16  
ON THE DISTRIBUTION OF BLOOD LITHIUM BETWEEN PLASMA AND CORPUSCLES. Didier Bertrand. *Bull. soc. chim. biol.* 33, No. 7, 827-8(1951). (In French)

The plasma and corpuscles of horse and human bloods were separated by centrifugation, and the Li contents were determined spectrographically. Since a larger proportion of the total Li was found in the plasma, a series of tests was run to determine the Li in the serum (considered as equivalent to the plasma) of eight men of military age. The average found was 27  $\mu\text{g}$ /liter of serum, with a maximum range of 23 to 31  $\mu\text{g}$ /liter. It is concluded that of the 19  $\mu\text{g}$  of Li/liter of human blood, 15 is in the plasma and 4 in the corpuscles.

17  
LITHIUM IN HUMAN BLOOD. Didier Bertrand. *Bull. soc. chim. biol.* 33, No. 7, 829-30(1951). (In French)

The Li contents of the blood of a series of young adult humans, 14 men and 10 women, were determined spectrographically. The average for both sexes was found to be 19  $\mu\text{g}$ /liter, with a maximum range for men of 10 to 27 and for women of 8 to 34  $\mu\text{g}$ /liter. Two consecutive determinations, with several weeks' interval, on one subject showed values of 13 and 24  $\mu\text{g}$ /liter.

18  
CLINICAL PROBLEMS IN THE LIGHT OF MODERN PHYSICS. Udo Köhler. *Ärzt. Forsch.* 5, No. 12, 1/449-54(1951) Oct. 10. (In German)

The influence of quantum theory on the development of biophysics, including such concepts as Jordan's quantum biology and the mutation theory of the origin of cancer, is discussed in a general fashion. Problems arising in therapy,

such as the phenomenon of temporary insensitiveness of cells to radiation, which cannot be satisfactorily explained by the target theory, indicate the need for more comprehensive theories in biology.

19  
BLOOD LIPIDS AND HUMAN ATHEROSCLEROSIS. II. THE INFLUENCE OF HEPARIN UPON LIPOPROTEIN METABOLISM. Dean M. Graham, Thomas P. Lyon, John W. Gofman, Hardin B. Jones, Alexander Yankley, John Simonton, and Sidney White. *Circulation* 4, 666-73(1951) November.

Heparin administered to rabbits and man causes profound reorientation in the distribution of low density lipoproteins, characterized by a shift of lipoproteins of high  $S_f$  rates to those of successively lower  $S_f$  rates. Heparin administered to cholesterol-fed rabbits prevents the development of high levels of  $S_f$  10 to 50 lipoproteins and retards the development of atherosclerosis in such animals. Following heparin administration the plasma contains an "active principle" associated with the ultracentrifugal globulins, which produces similar re-orientation of the lipoprotein spectrum in vitro. Heparin added directly to serum is ineffective in vitro. Intermittent heparin administration to patients with severe angina pectoris results in dramatic and uniform relief from this symptom for periods of several days beyond a single injection in 55 of 59 cases. (auth)

20  
RECENT STUDIES ON THE ETIOLOGY AND NATURE OF LEUKEMIA. J. Furth. *Blood* 6, 964-75(1951) Nov.

Recent investigations on chemicals (including hormones) causing leukemia are reviewed. Induction of leukemia by ionizing radiations (x rays,  $\gamma$  rays, slow or fast neutrons) and its prevention by chemical, hormonal, and physical protection is discussed. Recent research makes it seem possible that virus-like agents, the usual cause of leukemia in fowls, may cause it in mammals also. 42 references.

21  
THE SURFACE CHEMISTRY OF BONE. III. OBSERVATIONS ON THE ROLE OF PHOSPHATASE. W. F. Neuman, V. DiStefano, and B. J. Mulryan. *J. Biol. Chem.* 193, 227-34 (1951) Nov.

Experiments were performed to test the notion that glycerophosphate is inhibitory to calcification in the absence of active phosphatase. It was shown that ester phosphate is strongly adsorbed by bone mineral and that such adsorbed ester inhibits the accretion of additional mineral both in isolated inorganic systems and in calcifying slices of rachitic cartilage taken from rat tibia. The significance of these results is discussed. (auth)

22  
THE SURFACE CHEMISTRY OF BONE. IV. FURTHER DATA ON RECRYSTALLIZATION. W. F. Neuman and B. J. Mulryan. *J. Biol. Chem.* 193, 237-41(1951) Nov.

The interaction between powdered bone and radiophosphate buffer has been reinvestigated. It was found that the slow incorporation of labeled phosphate by the bone mineral requires the presence of an aqueous phase. It may be concluded that this slow reaction is primarily the result of a recrystallization process rather than a simple diffusion of the phosphate ion through the crystal lattice. (auth)

RADIATION EFFECTS

23  
Naval Radiological Defense Lab.  
PRE-PROTECTION OF MICE AGAINST X-IRRADIATION MORTALITY BY SODIUM NITRITE (Technical Objective AW-6); by L. J. Cole, V. P. Bond, and M. C. Fishler. Sept. 21, 1951. 14p. (AD-331(B))

The mortality of mice receiving 600- or 750-r single dose whole-body x irradiation was reduced markedly

following preirradiation intraperitoneal injection of  $\text{NaNO}_2$  (100 to 125 mg/kg). Definite, but less marked, protection was also observed with a nitrite dose of 62 mg/kg. The decrease in radiosensitivity afforded by  $\text{NaNO}_2$  administration was reflected in the minimal postirradiation body-weight losses observed in the nitrite-treated groups, as compared with the control animals. The possibility that nitrite protection is mediated via its effect on catalase activity is discussed.

24

Oak Ridge National Lab.

**THE OXYGEN EFFECT ON X-RAY-INDUCED CHROMATID ABERRATIONS IN *TRADESCANTIA* MICROSPORES;** by Herbert Parkes Riley, Norman H. Giles, Jr., and Alvin V. Beatty. [nd] 1p. (AECU-1685)

The report is reproduced here in its entirety.

Comparative x-ray dosage curves for the various types of chromatid aberrations (microspores examined at 24 hr following irradiation) have been obtained following exposures of inflorescences in atmospheres of pure  $\text{O}_2$  and of pure He. A constant x-ray intensity of 300 r/min was used, and four dosages were administered—between 25 and 150 r in  $\text{O}_2$ , and between 50 and 450 r in He. A linear relationship between aberration frequency and dose was obtained for both isochromatid and chromatid aberrations in both the presence and the absence of  $\text{O}_2$ . Aberration frequencies were higher in  $\text{O}_2$  in both instances, but the magnitude of the difference was much greater for isochromatid types (2.6) than for chromatid types (1.4). Nonlinear relationships were obtained for chromatid interchanges in both the presence and the absence of  $\text{O}_2$ , the exponents of the dosage curves being approximately the same (1.7) in both cases. For equivalent dosages, chromatid interchanges were almost four times as frequent in  $\text{O}_2$  as in He. Experiments have also been performed on the effect of intensity on aberration yield in the presence and in the absence of  $\text{O}_2$ . In  $\text{O}_2$ , a constant dose of 150 r was administered in  $\frac{1}{2}$ , 3, 15, and 30 min. In the absence of  $\text{O}_2$  (in  $\text{N}_2$ ), the same times of exposure were used, but a constant dose of 450 r was given in order to obtain comparable levels of biological response. There was no effect of intensity on the frequencies of chromatid and isochromatid aberrations. Chromatid exchanges decreased in frequency at lower intensities, generally similar types of curves being obtained for the two exposures. The results to date of the intensity experiments suggest that the average restitution time for broken ends is the same in the presence and in the absence of  $\text{O}_2$ , and thus support the view that  $\text{O}_2$  exerts its effect by increasing the initial frequency of breaks rather than by modifying the behavior of broken ends during the recovery process. (Paper presented at Genetic Society of America, Minneapolis, Sept. 9-12, 1951)

25

Oak Ridge National Lab.

**ALBUMIN EXCHANGE BETWEEN BLOOD AND LYMPH COMPARTMENTS AND ESTIMATION OF LYMPH VOLUME** (abstract); by R. H. Storey, M. C. Woods, and J. Furth. [nd] 1p. (AECU-1691)

The report is reproduced here in its entirety.

The rate of metabolism of  $\text{I}^{131}$ -labeled, homologous albumin and its disappearance rate from the blood vessels was studied in normal and x-rayed dogs with the aid of exteriorized lymph-venous anastomoses. The amounts of albumin disappearing from the blood during equilibration (deducting the amount metabolized) is proportional to that in the lymph compartment (lymphatics and tissue spaces). From the values thus obtained and from the albumin ratio between blood and lymph, the lymph volume can be calculated. In normal dogs the lymph volume is estimated to be approxi-

mately 80% of the plasma volume. In massively x-rayed animals the lymph volume is highly variable. The metabolism rate of  $\text{I}^{131}$ -labeled albumin in normal dogs is approximately 42% in 24 hr (i.e., 42% of the activity present at time zero has been metabolized from the two compartments in 24 hr) and is much reduced in dogs 4 to 14 days postirradiation. The albumin concentration in the lymph in relation to the blood albumin is increased in x-rayed dogs (normal ratio 0.6; 2 to 7 days after radiation 0.77 to 0.93). These findings indicate an increased capillary permeability caused by radiation. This is also evidenced by the presence of large numbers of erythrocytes in the lymph of x-rayed animals. Similar studies with  $\text{C}^{14}$ -labeled albumin are being conducted in normal and x-rayed rats. (Paper presented at American Physiol. Society, Sept. 1951, Salt Lake City)

26

Oak Ridge National Lab.

**THE RELATION BETWEEN THE EFFECTS OF TEMPERATURE AND OF OXYGEN ON THE FREQUENCY OF X-RAY-INDUCED CHROMOSOME ABERRATIONS IN *TRADESCANTIA* MICROSPORES** (abstract); by Norman H. Giles, Jr., Alvin V. Beatty, and Herbert Parks Riley. [nd] 1p. (AECU-1695)

The report is reproduced here in its entirety.

Previous experiments of Sax and others have shown that the frequencies of x-ray-induced chromosome aberrations in *Tradescantia* microspores are greater at low than at high temperatures. The discovery of the effect of oxygen in increasing x-ray-induced aberration frequencies suggested that the greater solubility of this gas in water at low temperatures might be responsible for this temperature effect. To test this possibility inflorescences were irradiated in experiments in which the amount of dissolved oxygen was varied over a similar range in terms of volumes per cent in two different ways: (1) by using a constant percentage of  $\text{O}_2$  (5%  $\text{O}_2$  plus 95% He) and making a series of exposures at several different temperatures, between 0.6 and 40°C, and (2) by using a constant temperature (27°C) and varying the percentage of  $\text{O}_2$  in the exposure chamber. Cytological analyses were made of chromosomal aberration types at the 4- to 5-day interval following irradiation. Exposures were also performed in the absence of  $\text{O}_2$  (in pure  $\text{N}_2$ ) at various temperatures. The experiments in  $\text{O}_2$  demonstrate that the increased yield of aberrations at low temperatures cannot be attributed entirely to increased  $\text{O}_2$  solubility. There is a considerable additional effect of temperature itself. In the absence of  $\text{O}_2$ , the unexpected result was obtained that the effect of temperature is exactly opposite to that noted in the presence of  $\text{O}_2$ —the yield of aberrations is considerably higher at high than at low temperatures. This situation is true not only for chromosome aberrations but also for all types of chromatid effects. The discovery of this reversal of the temperature effect in the absence of oxygen makes it unlikely that the effect of temperature is to be attributed solely to a modification of the behavior of broken chromosome ends during the recovery process. Rather, it seems probable that temperature exerts its effect, at least in the presence of  $\text{O}_2$ , on either the formation or effectiveness of some substance (or substances) which is produced in the cell by the radiation and which is responsible for chromosome breakage. (Paper presented at Genetic Society of America, Sept. 1951, Minneapolis)

27

Oak Ridge National Lab.

**EFFECTS OF INFRARED IRRADIATION ON THE FREQUENCY OF X- AND GAMMA-RAY-INDUCED CHROMOSOMAL ABERRATIONS IN *TRADESCANTIA* POLLEN TUBES** (abstract); by J. S. Kirby-Smith. [nd] 1p. (AECU-1696)



The report is reproduced here in its entirety.

*Tradescantia* pollen has been treated with 250-kv x rays and 13-Mev  $\gamma$  rays in combination with near-infrared radiation in the 9500 to 30,000 Å region. The temperature of the material during infrared radiation has been closely controlled to eliminate the possibility of thermal effects. Measurements of the infrared absorption spectra of *Tradescantia* pollen show that, in the present experiments, an appreciable amount of infrared energy is reaching the nuclei. Typical near-infrared absorption curves will be presented. The chromosomal aberration frequency in the pollen tube division following irradiation has been studied. No significant difference in the aberration frequency, including interchanges, has been observed between material treated with x or  $\gamma$  rays alone and material given near-infrared radiation immediately before or after exposure to x rays or  $\gamma$  rays. (Paper presented at Genetic Society of America, Sept. 1951, Minneapolis)

Argonne National Lab.

EFFECTS OF INJECTED RADIUM ON ALKALINE PHOSPHATASE ACTIVITY OF BONE AND TISSUES; by William P. Norris and Stanton H. Cohn. Oct. 1951. 22p. (AECU-1703; UAC-451)

The influence of radium as an internal  $\alpha$  emitter on the phosphatase activity of bone and tissue was studied in a number of rats injected with varying amounts of radium chloride. The results indicate that: radium deposited in bone causes significant reduction in the alkaline phosphatase content of bone; at least a part of the serum phosphatase is derived from bone; the phosphatase content of the soft tissues analyzed is largely independent of that of bone and is not affected by injection of radium; radiation dosages, from deposited radium, of the order of 1 to 10 rep/hr will produce significant reduction in the alkaline phosphatase content of bone within 24 hr; in vitro studies with x-rays and with radium added to serum and bone homogenates produced no change in phosphatase activity up to 10,000 r (therefore, the effect of deposited radium as reflected by the reduction in alkaline phosphatase activity is almost entirely on the phosphatase-forming elements of bone). (auth)

Oak Ridge National Lab.

THE EFFECT OF X RADIATION ON THE ADAPTIVE FORMATION OF FORMIC HYDROGENLYASE IN *ESCHERICHIA COLI* (abstract); by Daniel Billen and Herman C. Lichstein. [nd] 1p. (AECU-1705)

The report is reproduced here in its entirety.

During studies on the mechanism of X radiation effects on microorganisms carried out in this laboratory, the adaptive formation of formic hydrogenlyase in resting cell suspensions of *Escherichia coli* was investigated. The data show that X irradiation of resting cell suspensions of *E. coli*, in doses of 60,000 r or greater, prevents completely the ability to synthesize formic hydrogenlyase, while having no effect on preformed hydrogenlyase activity. (auth)

Los Alamos Scientific Lab.

PHYSICOCHEMICAL EFFECTS OF RADIATION; I. EFFECT OF X-RAYS ON FIBRINOGEN AS REVEALED BY THE ULTRACENTRIFUGE AND VISCOSITY; by Virgil L. Koenig and J. D. Perrings. [nd] 28p. (AECU-1725; LADC-1027)

Bovine fibrinogen irradiated in the dry state and dissolved in 0.1M NaCl and 0.1M  $\text{Na}_2\text{HPO}_4$  has been studied on the ultracentrifuge at various concentrations. Significant differences in the ultracentrifugal behavior were observed for different amounts of radiation. Significant differences

in viscosity behavior of irradiated fibrinogen dissolved in 0.1M  $\text{Na}_2\text{HPO}_4$  from the control unirradiated fibrinogen were observed. Fibrinogen irradiated in the presence of oxygen, nitrogen, and helium was studied on the ultracentrifuge. Fibrinogen irradiated in the presence of helium showed greater alteration than in either oxygen or nitrogen. Fibrinogen irradiated when dissolved in 0.1M  $\text{Na}_2\text{HPO}_4$  showed alteration. When the radiation was increased a heavier second component appeared on the ultracentrifuge diagram. Less radiation is required in the dissolved state than in the dry state to produce comparable changes. At least  $1 \times 10^6$  r is necessary in the dry state to produce a significant change in the fibrinogen. In the dissolved state  $5 \times 10^4$  r is sufficient to produce a significant change. (auth)

31

Army Medical Research Lab., Fort Knox  
THYROID RESPONSE TO TOTAL-BODY X-IRRADIATION; by A. L. Botkin, E. H. Praytor, Mary E. Austing, and J. Hensen. Sept. 28, 1951. 9p. (AMRL-66)

Changes in thyroid and serum  $\text{I}^{131}$  content (inorganic and organic) of rats, after total-body x irradiation at 1000 r, indicate a stimulation of thyroid activity by 2 hr after irradiation. This increased activity is apparent until one day after irradiation, from which time until the sixth day there is a progressive decrease in activity. These changes in functional activity of the thyroid are probably due to systemic damage caused by the radiation and are mediated through the hypophysis. The initial increased thyrotropin release from the hypophysis is followed by a shift of pituitary function toward increased adrenocorticotropin elaboration at the expense of thyrotropin production. (auth)

32

Naval Medical Research Station, Joint Task Force One  
A COMPARISON OF THE EFFECTS OF TEST ABLE ATOMIC BOMB IONIZING RADIATION AND X-RAYS ON SEEDS OF BARLEY, WHEAT, AND OATS; APPENDIX No. 25 TO THE FINAL REPORT; by Luther Smith. [nd] 17p. (NP-1900)

Comparisons were made of the biological effects on dormant seeds of barley, rye, and durum and common wheats of radiations from an atomic bomb and from known dosages of x rays. Effects studied included germination, flecking or mottling on the first leaves, chimeras, interchanges in  $X_1$  plants grown from the irradiated seeds, mutation frequencies in  $X_2$  seedlings, and types of mutants obtained in  $X_2$ . Seeds most heavily irradiated from the bomb burst were estimated to have received irradiation equivalent to 16,000 r of x ray. Plants from seeds which were subjected to 16,000 r x irradiation were used for comparison. There were no clear-cut differences in the types of seedling mutants obtained from the 2 sources of radiation nor in the relative proportions of these types.

33

Western Reserve Univ., School of Medicine  
THE SYNERGISTIC LETHAL ACTION OF CERTAIN RADIOISOTOPES IN RATS; by Paul R. Salerno, H. L. Friedell, James H. Christie, and Marvin Berg. Issued Oct. 22, 1951. 15p. (NYO-1624)

Synergistic lethal action has been clearly established with a number of internally distributed radioactive isotopes. The synergism appears to be a function of the simultaneous radiation injury of two separate systems. It would appear that the reticuloendothelial system and the hematopoietic systems are closely related and the effects are much more profound when both are injured than when the injury is confined to either one. An attempt to clarify the relationship between these two systems will be made by further

experiments. It is to be noted also that when two different isotopes are restricted to the same organ system by virtue of their distribution, the effects appear to be due to simple summation. (auth)

34

Oak Ridge National Lab.

ON THE ENERGY DISSIPATION OF MOVING IONS IN TISSUE; by W. S. Snyder and J. Neufeld. Issued Nov. 29, 1951. 14p. (ORNL-1083)

Fast-neutron irradiation of tissue produces recoil ions, and it is generally assumed that the biological damage is primarily due to the dissipation of the energy of these ions in the tissue. There are at least two mechanisms of damage, the nuclear collisions which directly displace the struck atom and thereby disrupt the molecular structure, and the electronic collisions which produce ionization and only indirectly produce chemical changes. The relative importance of these two interactions is computed solely on the basis of the relative amounts of energy absorbed through each. Curves of energy loss through each type of interaction are plotted as functions of velocity for moving ions of nuclear charge  $Z_1 = 1, 2, 6, 7$ , and  $8$ . The energies at which energy losses due to nuclear collisions become equal to the losses due to electronic collisions are as follows:  $Z_1 = 1$ ,  $E = 0.0015$  Mev;  $Z_1 = 2$ ,  $E = 0.013$  Mev;  $Z_1 = 6$ ,  $E = 0.094$  Mev;  $Z_1 = 7$ ,  $E = 0.13$  Mev; and  $Z_1 = 8$ ,  $E = 0.18$  Mev.

35

Atomic Energy Project, Univ. of Calif., Los Angeles  
SYSTEMIC EFFECTS OF IRRADIATION OF THE EXTERIORIZED SMALL INTESTINE IN RABBITS; by Marta S. Billings, A. H. Dowdy, Louise Burlingame, and Juanita Lampert. Issued Oct. 26, 1951. 30p. (UCLA-152)

The object of this work was to study the systemic effects of intestinal irradiation in rabbits. In order to eliminate irradiation of other intra-abdominal organs and structures, as well as side scatter effects to bone marrow, the irradiation was given directly to the small intestine after surgical exteriorization. Doses up to 1800 r did not cause any significant morbidity. Doses from 1800 to 6000 r caused illness after a latent period of 5 days terminating with 100% lethality in the fourth week. At no time did the animals exhibit diarrhea. Irradiation of the exteriorized small intestine had no immediate specific effect on the circulating blood cells. The eventually developing granulocytopenia and increase in red blood cells after intestinal exposure to doses of 2000 r or more appear to be the result of inanition and dehydration which follow local intestinal radiation injury. Leukopenia and anemia developing after total-body irradiation were not modified by lead shielding of the exteriorized small bowel. Lead protection of the exteriorized small intestine prevented initial shock and early death of rabbits after total-body irradiation. Lethal doses were slightly higher in the shielded group. (auth)

36

Atomic Energy Project, Univ. of Calif., Los Angeles  
CYTOLOGICAL EFFECTS OF X-IRRADIATION AND COLCHICINE APPLIED SEPARATELY AND IN COMBINATION; by Ole Arne Schjeide, Bennet M. Allen, and Ronald T. Piccirillo. Issued Nov. 16, 1951. 16p. (UCLA-165)

The combined application of 500 r x irradiation and 10- $\gamma$  colchicine produced an early acceleration in the rate of breakdown of the hematopoietic cells in tadpoles (*Rana catesbeiana*) as compared to the cell alterations produced by 500 r x irradiation alone or 10- $\gamma$  colchicine alone. This acceleration occurred between 4 and 8 hr post-treatment. A lag was evident in all three groups up to about 4 hr. The tadpoles were kept at 18 to 20°C. No such acceleration was

observed when double amounts of either agent alone were administered. In fact, doubling the dosage had no detectable effect in increasing the amount of cell alteration. At 8, 12, and 16 hr post-treatment the observed amount (not rate) of hematopoietic cell destruction in the case of 10- $\gamma$  colchicine plus 500 r x irradiation was more than double the amount of cell alteration observed in the case of colchicine alone or x irradiation alone. The amounts of cell alteration in the case of (a) colchicine and x rays in combination, (b) 500 r x irradiation alone, and (c) 10- $\gamma$  colchicine alone, became identical at 20 to 24 hr post-treatment. Possible mechanisms of the peculiar action of colchicine in combination with x rays were discussed. (auth)

37

Atomic Energy Project, Univ. of Calif., Los Angeles  
THE EFFECTS OF X-IRRADIATION ON GASTRO-INTESTINAL TRANSIT AND ABSORPTION AVAILABILITY; by R. D. Goodman, A. E. Lewis, and E. A. Schuck. Issued Nov. 15, 1951. 14p. (UCLA-168)

An analysis of the quantitative changes in gastrointestinal propulsion in x-irradiated rats is presented. Male white rats of the Wistar strain were whole-body irradiated with 450 r of 250-kv x rays at the rate of 99.4 r/min. Patterns of gastrointestinal transit and absorption availability were studied with Evans blue dye by the method described in Report UCLA-167 at 1, 2, 4, 7, 10, 14, and 21 days after the irradiation. Total-body x irradiation, under the conditions described, was followed by a moderate decrease in the gastric emptying rate. Since the transit time from the pylorus to the ileocecal junction was not affected to a significant degree, the data suggest that a change in gastric transit is the chief determinant of small-intestinal absorption availability following x irradiation. The maximum limit of absorption availability from the small intestine was markedly diminished following irradiation. The greatest change occurred between the 4th and 7th days after irradiation. A return to within normal limits was not achieved even by the 21st postirradiation day.

38

Radiation Lab., Univ. of Calif.  
EFFECTS OF TOTAL BODY IRRADIATION UPON LIPO-PROTEIN METABOLISM; by John E. Hewitt, Thomas L. Hayes, John W. Gofman, Hardin B. Jones, and Frank T. Pierce. [nd] 27p. (UCRL-1549)

An investigation was made of the lipid metabolic derangement produced in rabbits as a result of irradiation. A correlation was found to exist between the high level of total lipoprotein 30 hr after irradiation and subsequent death of the animal. Serum opalescence was associated with low-density lipoprotein only and not with total lipoprotein level. Changes observed in the lipoprotein levels after irradiation were found to be consistent with the theory of conversion of low-density lipoprotein to higher density components. The injection of heparin after irradiation hastened the return of lipoprotein levels to normal values. Injection of toluidine blue, protamine sulfate, or quinine produced changes in the lipoprotein pattern similar to those shown after irradiation.

39

THE EFFECT OF IONIZING RADIATIONS ON THE BROAD BEAN ROOT. PART IX Concluded. J. M. Thoday. *Brit. J. Radiology* 24, 622-8(1951) Nov.

A technique is shown by which estimations can be made of the percentage of expected deficient daughter cells of a certain number of cells in mitosis. Estimates of the number of singly and doubly deficient cells in *Vicia faba* root meristems per 100 cells after various dosages of x irradiation and of  $\alpha$  particles and percentages of fragmented nuclei are tabulated. Various mitotic stages are



considered. The ratio of relative efficiencies of highest doses of  $\alpha$  particles and of x rays in producing chromosome deficiencies is shown to be about homogeneous and both are also roughly equivalent in their inhibiting effects on tissue growth of root tips. This may support the hypothesis that the structural changes produced by ionizing radiations in *Vicia* root-tip cells contribute largely to inhibition of root growth caused by these radiations, for these doses are not equivalent in their effects on mitotic rate and probably not in their effect on gene mutation.

40

ON THE MECHANISM OF FERMENTATION INACTIVATION BY NEUTRONS. Kurt P. Jacobsohn and Marieta da Silveira. *Bull. soc. chim. biol.* 33, No. 7, 673-80(1951). (In French)

The enzymes fumaric hydratase, urease, alkaline serum phosphatase, serum cholinesterase, and thiaminase, either dry or in various aqueous substrates, were irradiated with x-ray, Ra, and Ra-Be sources. The fumaric hydratase, in particular, undergoes a sudden and total inactivation on irradiation by fast neutrons in aqueous fermentative extracts; no effect is noted when dry or when irradiated by slow neutrons,  $\gamma$  rays, or x rays. The conclusion that the destruction of the fermentation system is caused by products of neutron-induced decomposition of water is discussed.

41

NEUTRON AND X-RAY EXPERIMENTS IN BARLEY.

James MacKey. *Hereditas* 37, 421-64(1951).

Dry and presoaked seed of barley were treated with x rays and fast neutrons, and the biological effect of the irradiation was followed through the first and second generation. For dry, dormant seed the germinability was normal even after the heaviest dose applied. The retardation of the initial seedling growth was, however, pronounced, giving a sigmoid relation to x-ray dose and an exponential one to neutron dose. The frequency of mature plants, i.e., the survival fraction, seems to be nearly equal in  $X_1$  and  $N_1$  at comparable tissue doses. The cytological response in the first mitotic cycle to irradiation showed an N/X efficiency quotient of 10, if the frequency of fragments and bridges were registered, whereas the fraction of affected seeds, the plant fertility, and the rate of induced chlorophyll mutations gave N/X ratios of 65/75. For the two last-mentioned biological events a pronounced saturation effect was, however, intervening in  $X_1$ , indicating that a contra-selection had set in. Presoaking of the seed did not change this difference in the biological action of x rays and neutrons. In  $X_1$  the increased sensibility of the chromosomes was paralleled by an increased physiological killing. A more pronounced energy absorption due to the high moderating effect of water in the case of neutrons explains why the lethality after presoaking in  $N_1$  falls considerably below that of  $X_1$ . The types of induced chlorophyll mutations and their relative proportions were the same in  $X_2$  and  $N_2$ . At the high doses used in the present study no correlation between degrees of sterility in the first generation and different categories of chlorophyll mutation in the second has been found. After both types of radiation the mutations were to a great extent associated with chromosome disturbances. 108 references.

42

JACKSON EPILEPSY FOLLOWING HIGH ENERGY SHORT DISTANCE IRRADIATION OF A TEMPLE MELANOMA. Wilhelm Hornberger. *Strahlentherapie* 85, 459-76(1951).

Case histories and literature on late x-irradiation injuries are discussed. A case of Jackson epilepsy due to 18,000 r short-distance Chaoul tube irradiation of a temple melanoma is described and permissible limits for such irradiation are considered.

43

NUCLEOLAR CHANGES INDUCED IN THE GRASSHOPPER NEUROBLAST BY DIFFERENT WAVELENGTHS OF ULTRAVIOLET RADIATION AND THEIR CAPACITY FOR PHOTORECOVERY. J. Gordon Carlson and Rachel D. McMaster. *Exptl. Cell Research* 11, 434-44(1951).

Spheration induced in the nucleolus of the grasshopper neuroblast by wavelengths 2250, 2399, 2537, 2650, 2804, 3022, and 3130 Å was studied. Photorecovery was not evidenced after treatment with 2250, 2399, or 2537 Å. It was highly significant after 2650 and 3022 Å, and probably could have been demonstrated after 2804 and 3130 Å if the data had been more extensive. Wavelengths 2650 and 2804 Å are the most effective ones in inducing nucleolar spheration. Above 2804 Å and below 2650 Å the effectiveness of the ultraviolet gradually decreases. At 3650 Å no effect was obtained even after prolonged exposure to radiation of high intensity. The time interval between the termination of ultraviolet treatment and maximum spheration, as determined by the per cent of cells affected, is independent of wavelength and dose. Spheration persists for periods of time varying directly with the per cent of cells affected and appears to be independent of the dose. Interphase nucleoli are the most sensitive followed by very early prophase, early prophase, middle prophase, and late prophase, in order of decreasing sensitivity. Spheration appears to result from direct action of the radiation on the nucleolus or on the material immediately surrounding it. The effects produced on the nucleolus by ultraviolet, heat, and x rays resemble each other only superficially. (auth)

44

EFFECT OF TEMPERATURE ON THE SENSITIVITY OF WHEAT GERMINATION TO X RADIATION. R. G. Trudova. *Doklady Akad. Nauk S.S.S.R.* 79, No. 2, 353-6(1951) July 11. (In Russian)

Effects on the mitotic activity of the root-tip meristem of wheat of 500 r of x radiation prior to exposure at 0, 20, and 36°C and of 250, 500, 1000, and 2000 r following exposure to these temperatures are presented graphically.

RADIATION HAZARDS AND PROTECTION

45

Oak Ridge National Lab.

FAILURE OF HYPOXIA TO PROTECT AGAINST THE RADIATION INDUCTION OF DOMINANT LETHALS IN MICE (abstract); by W. L. Russell, J. C. Kile, Jr., and Liane B. Russell. [nd] 1p. (AECU-1686)

The report is reproduced here in its entirety.

To test whether hypoxia would protect against radiation induction of dominant lethals in mice, groups of males were (a) x-irradiated with 800 r in air, (b) nonirradiated in air, (c) x-irradiated with 800 r in a 5%  $O_2$ -95% He mixture, or (d) nonirradiated in the same mixture. The gas was passed through the exposure chamber for 5 min prior to irradiation and during irradiation in exposed groups and for the equivalent time in nonirradiated groups. Females fertilized by these males shortly after treatment were opened just before term and their uterine contents examined. Classifying embryos as alive or dead (including resorption sites) gave the following mean numbers of the two respective types per litter, with from 47 to 50 litters in each group: (a) 3.9 and 3.6, (b) 8.2 and 0.98, (c) 3.6 and 3.5, (d) 8.3 and 0.96. Repetitions of the experiment with 30-min pretreatment in the same gas mixture and irradiation in this or in 2%  $O_2$ -98% He gave similar results. These data give no evidence for protection by hypoxia against the induction of dominant lethals to which the excess death of embryos from irradiated sires is attributable. This is in contrast to the protection against

genetic damage found by others in various organisms. It is also in contrast to protection by hypoxia, in this experiment, against direct radiation effects on the exposed males: acute radiation death reduced from 92 to 0%, length of sterile period and graying of hair decreased. (Paper presented at Genetic Society of America, Sept. 1951, Minneapolis)

46

Oak Ridge National Lab.

MODIFICATION OF THE EFFECTS OF X RAYS ON STOCK 90 OF VARIETY 1 OF *PARAMECIUM AURELIA* (abstract); by R. F. Kimball. [nd] 1p. (AECU-1689)

The report is reproduced here in its entirety.

Various conditions have been used to attempt to modify the effect of x rays as measured by death and number of divisions in the first day after irradiation and by reduced vigor and death after autogamy. The postautogamous effects were less severe when the animals were irradiated under low oxygen tension or in 0.6M ethyl alcohol. No noticeable effect was exerted by starvation before irradiation, temperature during the day after irradiation (9 to 31°C), or presence of 0.001M sodium hydrosulfite ( $\text{Na}_2\text{S}_2\text{O}_4$ ), 0.0009M British anti-Lewisite (BAL), or 0.01M sodium formate. The last three compounds and alcohol were tried because they had been found by others in this laboratory to protect bacteria against inactivation by x rays. The oxygen effect is well known for a variety of organisms as a result of work in this and other laboratories. The negative results with hydrosulfite and BAL are not too significant since very low concentrations had to be used. Quite different results were obtained in the investigations of death and division delay in the first day. Low oxygen tension, BAL, and formate cause increased death and delay in division. All three treatments have a distinctly injurious effect upon the control animals, and it seems probable that this injurious effect combined with that of the radiation accounts for the results. It is surprising that low oxygen tension which clearly protects against postautogamous effects fails to do so for the immediate effects. Alcohol and hydrosulfite both decrease division delay despite the fact that they are clearly injurious to unirradiated animals. However, in some experiments, there is more death following irradiation in the presence of these agents than in their absence, suggesting again a combination of injurious effects. Finally, both division delay and death are markedly greater when the animals are irradiated in phosphate buffer with 3% of culture fluid added than when irradiated in undiluted culture fluid, suggesting a protective action of one or more of the components of the culture fluid. One can conclude that it is possible to protect paramecia against both the genetic and nongenetic effects of x rays, but it is not necessarily true that an agent which protects against the one will protect against the other. It appears likely that this is due, at least in part, to the independent injurious action of the x rays and of the substance adding together to produce a total effect greater than for either alone. (Paper presented at Paramecium Genetics Symposium, Sept. 1951, Bloomington, Ind.)

47

Oak Ridge National Lab.

PROBABLE MECHANISMS OF PROTECTIVE ACTION OF SOME CHEMICALS AGAINST RADIATION DAMAGE (abstract); by George E. Stapleton, Daniel Billen, and Alexander Hollaender. [nd] 1p. (AECU-1690)

The report is reproduced here in its entirety.

The protective action against x-ray damage of a wide variety of chemical substances on *E. coli* B/r has been reported (Burnett et al., *Federation Proc.* 10, 22(1951)). Some of these compounds have been further investigated in an at-

tempt to elucidate the mechanism of protection of bacterial cells. At low temperatures some of the commonly metabolized compounds, e.g., formate, succinate, serine, threonine, and  $\alpha$ -alanine, afford little if any protection. However, if cells were incubated at 37°C in the presence of these compounds, prior to x irradiation, a marked increase in their protective capacity was noted. Parallel studies on respiration, utilizing some of these compounds as substrates, indicate that their protective capacity can be correlated with the rate at which these substances are oxidized by the bacterial cells. This suggests that preincubation of cells with these compounds may result in protection, in part, by removal of oxygen at critical locations within the cell, thereby inhibiting the formation of some oxidizing radiodecomposition products of water. Further confirmation of the suggested mechanism has been obtained by use of respiratory inhibitors such as sodium cyanide. The inhibition of oxygen uptake by NaCN on several substrates used (amino and carboxylic acids) resulted in loss of protective action by these compounds. Some organic and inorganic sulfur-containing compounds which show protective action have been investigated in a similar manner and the results will be discussed in relation to the proposed mechanism. (Paper presented at Botanical Society of America, Physiol. Section, Sept. 1951, Minneapolis)

48

Oak Ridge National Lab.

MODIFICATION OF THE ACTION OF X RAYS UPON *PARAMECIUM AURELIA* (abstract); by R. F. Kimball and Nenita Gaither. [nd] 1p. (AECU-1694)

The report is reproduced here in its entirety.

A number of agents which previously have been shown to modify one or more effects of x irradiation have been tested on *Paramecium aurelia*. The mutagenic action of x rays in doses of 1 to 6 kr was found to be reduced when the irradiation was performed in an atmosphere of  $\text{N}_2$  or in the presence of 0.7M ethyl alcohol. On the other hand, 0.001M sodium hydrosulfite, a reducing agent, had no influence on mutagenesis. No effect of the metabolic state was found since irradiation of either fed or starved paramecia, with or without incubation with 0.01M sodium formate, produced identical amounts of mutation. Likewise, the rapidity of multiplication of the cells after irradiation, as influenced by temperature, was without influence. Two nongenetic actions, division retardation and death within 24 hr, were studied using doses of 100 to 300 kr. Both the amount of division retardation and of death were decreased by 0.7M ethyl alcohol present during irradiation. Sodium hydrosulfite (0.001M) clearly protected against the lethal action but had no influence upon division delay or, perhaps, enhanced it. Neither starvation nor incubation with formate was found to have any effect. Thus there is at least one agent which affects a variety of different kinds of radiation damage in *Paramecium*. It may be suggested that some step which is common to the various effects is involved. However, it is possible that some agents influence the steps leading to certain kinds of damage only or else act more effectively upon one kind than the other. (Paper presented at Genetic Society of America, Sept. 1951, Minneapolis)

49

Oak Ridge National Lab.

CHEMICAL ASPECTS OF RADIATION SENSITIVITY ON LIVING CELLS (abstract); by Alexander Hollaender, George E. Stapleton, and W. T. Burnett, Jr. [nd] 2p. (AECU-1699)

The report is reproduced here in its entirety.

Remarkable decreases in many x-ray-induced cellular phenomena by reduction of oxygen concentration during irradiation have been reported including alteration of inacti-



vation rates, frequencies of lethal mutations and chromosomal aberrations, as well as the duration of mitotic inhibition. As an extension of these studies an investigation has been made concerning the ability of chemical substances to modify the cell sensitivity to the damaging effect of x rays. The discussion will deal mainly with the results of x-ray lethal effects obtained with bacteria, but will include also studies with other organisms as far as the data are available. The following groups of chemical compounds have been found to reduce significantly the x-ray lethal effect on bacterial cells: sulfhydryl compounds (cysteine, BAL, mercapto succinic acid, and others), reducing compounds (sodium hydrosulfite), respiratory inhibitors (sodium cyanide), alcohols and glycols, carboxylic acids (formic, succinic, etc.), and sugars (glucose). It is interesting that compounds of group one and two will protect at either 2 or 37°C. High concentrations (10 to 20%) of the alcohols are required to give significant protection at low temperature (2°C) while much lower concentrations (<1%) are effective if the cells are incubated with them for a short period (30 min) at 37°C prior to irradiation. The carboxylic acids and glucose are effective only if the bacterial cells are incubated with them prior to x-ray exposure. Several of these compounds have been tested with interesting results for protective action on mice. The interpretation of results on the basis of removal of radiodecomposition products of water will be given. All of the chemical compounds used yield similar curves relating protective action to concentration, indicating a saturation phenomenon, the plateau level being different for the different types of compounds used. If two compounds are used simultaneously at the plateau level, additional protection is obtained, indicating perhaps different protective-mechanisms. The possible role of metabolism, reductive capacity as well as synthetic processes, especially nucleic acid synthesis in the protective action of the carboxylic acids, amino acids, and glucose, will be indicated. The significance of these findings on the chemistry of radiation damage in general will be discussed. (Paper presented at the American Chemical Society, New York City, Sept. 3-7, 1951)

50 Western Reserve Univ., School of Medicine  
THE EFFECT OF ORAL TERRAMYCIN ON WHOLE BODY X-RADIATION; by Gordon E. Gustafson, and Simon Koletsky. Issued Oct. 26, 1951. 10p. (NYO-1635)

Terramycin has been shown to be effective in reducing the mortality in rats when administered for a period of only 48 hr prior to 660 r of whole-body x-radiation. (auth)

51 PROTECTION OF MICE AGAINST A LETHAL DOSE OF X RAYS BY CYANIDE, AZIDE, AND MALONONITRILE. Z. M. Bacq and A. Herve. Brit. J. Radiology 24, 617-21 (1951) Nov.

Cyanides (but not thiocyanate or cyanate), azide ( $\text{NaN}_3$ ) and malononitrile protect a significant percentage of mice irradiated by a single lethal whole-body dose of x rays; these poisons are ineffective when given after irradiation. The protective effect of previously injected glutathione has been confirmed; the action of cyanide is increased by simultaneous administration of glutathione.

52 INJURIES TO HEALTH FOLLOWING UNCONTROLLED NUCLEAR FISSION CHAIN REACTIONS. Georg L. Wied and Gerhard Schmidt. Ärztl. Forsch. 5, No. 12, 1/455-65(1951) Oct. 10. (In German)

A review of injuries caused by atomic bombs and of indicated treatment is presented, the data being taken from the published literature. 40 references.

53 CHEMICAL PROPHYLAXIS OF RADIATION INJURIES. H. Langendorff. Strahlentherapie 85, 391-400(1951). (In German)

When acting on higher organisms, high energy radiations always produce a local radiation injury and also a general stress situation caused by the upset of interaction between the vegetative nervous system and endocrine gland function. The prophylactic action of certain chemicals is explained: cysteine, glutathione, p-chloromercuribenzoate, BAL, KCN, and  $\text{HgCl}_2$  effect cell reactions locally; general stress-damping effects result from usage of doca (desoxycorticosterone acetate), rutin, pyridoxin (Vitamin  $\text{B}_6$ ), nicotinamide, d-catechol, and antibiotics. The importance of compounds protecting free SH-groups is stressed.

54 STUDIES ON THE REMOVAL OF RADIOACTIVE CONTAMINANTS FROM WATER. Conrad P. Straub, Roy J. Morton and Oliver R. Placak. J. Am. Water Works Assoc. 43, 773-92(1951) Oct.

The removal of single radioisotopes and of combinations of radioisotopes from waste solutions by conventional water-treatment techniques are reported. Such modified procedures as phosphate coagulation and clay adsorption were also used. Typical results obtained with a pilot plant are included.

#### RADIATION SICKNESS

55 THERAPEUTIC EFFECTS OF VITAMIN B<sub>12</sub> AND SIMILAR CHEMICAL SUBSTANCES ON RADIATION SICKNESS AND ON CONDITIONS CAUSED BY MALIGNANT TUMORS. Willie Renner. Strahlentherapie 85, 342-6(1951).

Vitamin B<sub>12</sub> was used successfully in counteracting radiation sickness and tumor toxicity. Cobalt porphyrines were ineffective.

56 EXPERIMENTAL INVESTIGATION ON EFFECTS OF VITAMINS ON LIVER METABOLISM IN ANIMALS SUFFERING FROM RADIATION INJURIES. R. Koch and A. Bohlander. Strahlentherapie 85, 331-41(1951)

Total-body x radiation in white mice resulted in a reduction of the liver glycogen to 27% of its original value. In homogeneous and heterogeneous animal material, the distribution of the liver glycogen corresponds to that of the normal Gaussian distribution. No quantitative changes of the total N content of the liver were found.

57 MODIFICATION OF IRRADIATION INJURY IN MICE AND GUINEA PIGS BY BONE MARROW INJECTIONS. Egon Lorenz, Delta Uphoff, T. R. Reid, and Emma Shelton. J. Natl. Cancer Inst. 12, 197-201(1951) Aug.

Data indicate that bone marrow injected either intravenously or intraperitoneally postirradiation gives excellent protection to mice and guinea pigs from the acute irradiation syndrome.

58 TREATMENT OF RADIATION SICKNESS WITH ACTH. Kenneth W. Taber. Radiology 57, 702-9(1951) Nov.

Patients treated for x-radiation sickness exclusively with 10-mg intramuscular doses of adrenocorticotrophic hormone showed prompt relief of symptoms after a few injections. The lives of white mice receiving 300 r of total-body x irradiation were saved by daily injections of ACTH for 10 days in doses comparable to those given the human patients. ACTH also prolonged the lives of mice which received 600 r of total-body irradiation. The theory upon which this study is based is discussed.

## RADIOGRAPHY

59

Oregon Univ.  
PROGRESS REPORT ON RESEARCH IN THE MEASUREMENT OF BETA AND GAMMA RADIATION IN THE ATMOSPHERE WITH SPECIAL REFERENCE TO INVESTIGATION OF SOFT X-RAYS WITH SCINTILLATION COUNTERS; MARCH 16 TO MAY 31, 1950 (Report No. 4); by A. E. Caswell. June 1, 1950. 26p. (NP-3479; U-17363)

60

PROBLEMS IN THE MEASUREMENT OF BONE DENSITY. Harris Jackson. *Brit. J. Radiology* 24, 613-16(1951) Nov.

The significance of the soft tissue matrix of bone, and of the scattering effects of the surrounding soft tissues has been found to be considerable in the measurement of bone density. A simple method of standardizing these effects is to radiograph the part in a tray with added water to make a constant total volume.

61

TRITIUM IN RADIOAUTOGRAPHY. Patrick J. Fitzgerald, M. L. Eidinoff, J. E. Knoll, and E. B. Simmel. *Science* 114, 494-8(1951) Nov.

Tritium, with radioautography, has been found useful as a tool in biological tracer studies. The half life of tritium of  $12.1 \pm 0.5$  yr is more than adequate for radioautographic studies. Tritium atoms bonded stably to carbon can be used for labeling of carbon atoms. In many cases it may be less difficult to introduce tritium by catalytic reduction of a related compound or by isotopic exchange with an inactive compound than to prepare tracer compounds using radiocarbon. Since tritium is the radioactive isotope of an element commonly occurring in biological material, since it emits  $\beta$  particles having a maximum energy of 17.9 kev and a maximum range of about  $6 \mu$  in a medium of unit density, and since the average density of nuclear plates is between 3 and 4, the longest tracks are about  $2 \mu$ , which is compatible with intracellular resolution. Applications of the technique using paramecium and yeast are discussed.

## RADIOTHERAPY

62

Army Medical Research Lab., Fort Knox  
AN AID TO ACCURACY IN ROENTGENOGRAPHY; by Arthur Carpenter. Sept. 3, 1951. 14p. (AMRL-62)

A simple optical attachment for an x-ray tube stand is described which eliminates alignment errors by permitting the operating technician to sight along the axis of the x-ray beam without in any way interfering with the beam or limiting its range of adjustment. The attachment is adaptable to either fixed x-ray units or portable field-type equipment.

63

TISSUE DISTRIBUTION OF PETEOSTHOR AND ITS COMPONENTS THORIUM X AND PLATINUM IN THE GROWING ORGANISM AND THE INFLUENCE OF THORIUM X ON EPIPHYSEAL PLATE GROWTH IN THE YOUNG RABBIT. Wilhelm Koch. *Strahlentherapie* 85, 253-89(1951). (In German)

In the organism, ThX ( $Ra^{224}$ ) and Pt deposits each, independently, favor particular organs. Due to the dysfunction of the enchondral ossification, a several weeks' ThX treatment in rabbits results in a retardation of the growth in length; an impoverishment of the bones in Ca salts; the occurrence of spontaneous fractures, a lesser weight increase and premature birth in the pregnant animal. The selective ThX deposit in the newly calcifying and ossifying tissues permits a ThX therapy in all cases where calcifications and ossifications are primarily involved. During pregnancy and in children, this treatment is contra-indicated. (auth)

64

A CONTRIBUTION TO THE DOSAGE DETERMINATION OF GRENZ RAYS IN THE TREATMENT OF ALLERGIC SKIN DISEASES. Harald Oberste-Lehn. *Strahlentherapie* 85, 347-9(1951).

In the treatment of allergic skin diseases, a dose of 750 r Bucky is necessary in order to bring forth a distinct reduction of the antigen antibody reaction. An 8-day period of this effect is statistically guaranteed. It is assumed that, beyond this time limit, an effect on the successfully treated organ is possible up to the 14th day.

65

CONTRIBUTION TO THE TUMOR PROBLEM AND IMMUNE BODY FORMATION AFTER IRRADIATION OF CARCINOMAS. Karl Steffens. *Strahlentherapie* 85, 435-44(1951).

Physiological differences between proliferating benign body cells and cells forming malignant blastomas, due to developmental background of these cells, are discussed. Blood transfusions from persons showing blastoma remissions as a result of radiation to patients with metastases of the same organic origin showed no effect.

66

INDIRECT IRRADIATION IN MULTIPLE SCLEROSIS AND OTHER NEUROLOGICAL DISEASES. D. Bente and W. Schneider. *Strahlentherapie* 85, 445-57(1951).

Indirect irradiation is used in radiotherapy of multiple sclerosis and other neurological diseases. Irradiation is applied according to a definite time and local distribution schedule and is thought to be effective through neurogenic accessory cells (Kornmueller). The sympathetic trunk is the most important carrier of the radioreaction.

67

STUDIES WITH RADIOIODINE. III. PROBLEM OF DOSAGE IN THE TREATMENT OF HYPERTHYROIDISM. Earl R. Miller and Glenn E. Sheline. *Radiology* 57, 720-8(1951) Nov.

Attempts to predetermine radiation dose of radioiodine, expressed in roentgens of radiation to the thyroid gland, in the treatment of hyperthyroidism are reviewed. Discrepancies in data obtained from test and therapeutic doses are discussed. Results of treatment of hyperthyroid patients with  $I^{131}$  are presented in tabular form.

68

THYROID CARCINOMA WITH MULTIPLE METASTASES AND PATHOLOGICAL FRACTURE, SUCCESSFULLY TREATED WITH RADIOIODINE Joseph Sorrentino, Bernard Roswit, and Rosalyn Yalow. *Radiology* 57, 729-37(1951) Nov.

A patient with papillary follicular adenocarcinoma of the thyroid gland with multiple bony and soft-tissue metastases was treated with  $1,246 \mu c$  of  $I^{131}$  over a period of more than two years. This patient, hopelessly involved with advanced metastatic carcinoma on admission, has been clinically well for two years. His improvement began only two months after institution of radioiodine therapy. (auth)

## TOXICOLOGY STUDIES

69

Atomic Energy Project, Univ. of Calif., Los Angeles  
GASTROINTESTINAL ABSORPTION OF IONS; I. AGENTS DIMINISHING ABSORPTION OF STRONTIUM; by Norman S. MacDonald, Ralph E. Nusbaum, Florita Ezmirlian, Richard Barbera, George V. Alexander, Patricia Spain, and Donald E. Rounds. Nov. 13, 1951. 13p. (UCLA-169)

Thirty-two chemical agents, readily available in tonnage quantities, were screened for their ability to diminish the skeletal deposition of ingested Sr by gastrointestinal absorption. Aqueous  $SrCl_2$  solution was administered to fasted



rats by stomach tube, and followed immediately by an aqueous solution or suspension of the agent under study. After 24 hr, the Sr content of the femurs was determined by an emission spectrographic technique. The materials which definitely decreased skeletal accumulation of  $\text{Sr}^{++}$  are listed in order of decreasing efficacy:  $\text{MgSO}_4$ ,  $\text{Na}_2\text{SO}_4$ , the ammonium salt of an amido-polyphosphate, two carboxylic type cation exchange resins, a colloidal phosphorylated glucoside, calcium phytate, pectin, bran cereal, castor oil and a hydrophilic laxative derived from plantago. None of the following materials significantly altered the amount of deposition: bentonite, kaolin, hydrated alumina, soluble starch, methyl cellulose, carboxy methyl cellulose, agar, gum acacia, crude lignified cellulose, gelatin, fresh egg white, oatmeal, phenolphthalein, mineral oil and the disodium salt of ethylene diamine tetra acetic acid. Powdered milk, tannic acid, inulin, sodium alginate and a carboxylic and sulfuric acid substituted starch, all increased the skeletal accumulation of ingested Sr. (auth)

70

Amino Energy Project, Univ. of Calif., Los Angeles  
THE SKELETAL DEPOSITION OF YTTRIUM; by Norman S. MacDonald, Ralph E. Nusbaum, George V. Alexander, Florita Ezmirlan, Patricia Spain, and Donald E. Rounds. Nov. 16, 1951. 10p. (UCLA-170)

The accumulation of nonradioactive Y in the bones of growing rats was studied.  $\text{YCl}_3$  was administered intraperitoneally every two days, the greatest number of injections being 83. Analyses of the ashed femur ends and shafts were made by an emission spectrographic technique. Chronic systemic toxic effects were not obvious. Large amounts of Y did not accumulate—the level never exceeded 330 ppm of bone ash, about 1/100 the uptake of Sr after similar dosages. After the bone was burdened with 150 to 200 ppm of Y (~50 mg injected), further accumulation became more difficult, possibly because a second process of slower rate achieved dominance. The ratio of the amount of Y in spongy bone to that in compact bone approaches unity with the passage of time. It is concluded that Y is not a "bone-seeker" of the same degree as Sr and Pb. (auth)

#### TRACER APPLICATIONS

71

Wisconsin Univ., Coll. of Agriculture  
COMPARISON OF THE METABOLISM OF AMMONIA AND MOLECULAR NITROGEN IN PHOTOSYNTHESIZING BACTERIA; by J. S. Wall, A. C. Wagenknecht, J. W. Newton, and R. H. Burris. 27p. (AECU-1678)

Representatives of three groups of photosynthetic bacteria, *Chromatium*, *Chlorobacterium*, and *Rhodospirillum rubrum*, were supplied  $\text{N}^{15}$ -enriched  $\text{N}_2$  for short periods, and a culture of *Chromatium* also was given  $\text{N}^{15}$ -enriched ammonia. The bacterial cells were recovered and hydrolyzed, and the amino acids and ammonia from the hydrolyzates were isolated by chromatographic procedures. Determination of the distribution of the  $\text{N}^{15}$  indicated in every instance that the highest concentration of  $\text{N}^{15}$  was in glutamic acid. The ammonia fraction always had the next highest concentration. This distribution of  $\text{N}^{15}$  in ammonia, glutamic acid, and the other amino acids is similar to that found earlier in *Azotobacter*, *Clostridium* and the nodules of leguminous plants supplied the isotope. The data indicate that ammonia is a

key intermediate in biological nitrogen fixation by the photosynthetic bacteria. (auth)

72

THE VIRUS EFFECT ON THE UPTAKE OF  $\text{C}^{14}$  FROM GLUCOSE IN VITRO BY AMINO ACIDS IN MOUSE BRAIN. Max E. Rafelson, Jr., Richard J. Winzler, and Harold E. Pearson. J. Biol. Chem. 193, 205-17(1951) Nov.

The extent of incorporation of  $\text{C}^{14}$  from glucose into the amino acids of minced 1-day-old mouse brain incubated with uniformly labeled  $\text{C}^{14}$ -glucose and effect of presence or absence of Theiler's GD VII virus are studied. Radioactive peaks of roughly comparable specific activity are shown to be associated with all amino acids except proline and threonine. The presence of virus stimulated  $\text{C}^{14}$  uptake into most amino acids, inhibited uptake into lysine and histidine, and reduced amounts of the latter two amino acids in the tissues. The data given suggest that virus propagation in the in vitro system is intimately associated with effects on lysine and histidine metabolism.

73

ISOTOPES IN BIOCHEMICAL INVESTIGATIONS. W. A. J. Borg. Chem. Weekblad 47, 708-17(1951) Sept. 22. (In Dutch)

A fairly extensive review of representative applications of D, T,  $\text{C}^{13}$ ,  $\text{C}^{14}$ ,  $\text{N}^{15}$ ,  $\text{S}^{35}$ , and  $\text{I}^{131}$  to problems in biosynthesis, isotopic-dilution analysis, and metabolism is presented. 72 references.

74

EXCRETION AND TISSUE DISTRIBUTION STUDIES ON RADIOACTIVE NICOTINE. Aaron Ganz, F. E. Kelsey, and E. M. K. Geiling. J. Pharmacol. Exptl. Therap. 103, 209-14 (1951) Oct.

Radioactive nicotine was prepared by growing *Nicotiana rustica* plants in the presence of radioactive  $\text{CO}_2$ . After isolation of the radioactive nicotine, studies were performed on its distribution and excretion in the mouse, the urinary excretion in the rat, and on the fixation of nicotine by isolated guinea-pig hearts.

75

THE RELATION OF PHOTOSYNTHESIS TO RESPIRATION. J. W. Weigl, P. M. Warrington, and M. Calvin. J. Am. Chem. Soc. 73, 5058-63(1951) Nov. (See also NSA 4-6533 and 5-325)

The gas exchange of barley leaves has been studied in a closed system. Partial pressures of oxygen, carbon dioxide, and added radiocarbon dioxide were measured simultaneously during periods of illumination and darkness. The following conclusions were reached: In strong light respiratory carbon dioxide originates primarily from endogenous sources and only to a very slight extent from recently assimilated carbon. In the dark recently photosynthesized compounds are actively oxidized in a fairly constant ratio to endogenous respiration. Photosynthesis proceeds at a measurable rate even at the lowest  $\text{CO}_2$  pressures observed (0.03 mm). There is no evidence for a "threshold" concentration of carbon dioxide for the reaction; at the lowest concentrations reached, respiration exactly equals assimilation. On the one experiment which could be evaluated, the mean rate of respiratory  $\text{CO}_2$  evolution in strong light was found to be less than that in the dark. Internal rephotosynthesis of respiratory carbon may have been sufficient to account for this effect. Under the conditions of these experiments the assimilation of  $\text{C}^{14}\text{O}_2$  was found to be about 17% slower than that of  $\text{C}^{12}\text{O}_2$ . (auth)

## CHEMISTRY

76

Clinton Lab.

ION EXCHANGE EQUILIBRIA INVOLVING FISSION PRODUCTS AND THORIUM IN URANYL NITRATE; by Jack Schubert. Jan. 1, 1945. Decl. Nov. 14, 1951. 23p. (AEC-3273; CN-1873(excerpt only))

A study is reported on the behavior of ions present in tracer concentrations in the presence of large amounts of a bulk ion. The uranyl form of Amberlite IR-1, ( $\text{UO}_2\text{R}_2$ ), immersed in an aqueous solution of  $\text{UO}_2(\text{NO}_3)_2$  containing radiochemical amounts of the cation  $\text{M}^{+n}$  is discussed. The activity coefficients, per cent absorption, etc., are tabulated for the exchange reactions of La, Sr, and Th, with U in  $\text{UO}_2(\text{NO}_3)_2$  and the resin  $\text{UO}_2\text{R}_2$ .

77

Argonne National Lab.

STABILITY OF ALKALINE EARTH-ORGANIC ACID COMPLEXES IN ISOTONIC, NEUTRAL MEDIA MEASURED BY ION EXCHANGE; by Jack Schubert and Arthur Lindenbaum. Sept. 1951. 17p. (AECU-1677; UAC-438)

The formation constants for the complex ions formed between  $\text{Ca}^{++}$  and  $\text{Sr}^{++}$  and a series of mono-, di-, and tricarboxylic acids have been measured in buffered solutions at pH 7.2 to 7.3,  $\mu = 0.16$ , and  $t = 25^\circ\text{C}$  by the equilibrium ion exchange technique. All the complex ions formed were of the 1:1 type. The degree of complex formation is found to be a function of the number, kind, and position of the groupings within the organic molecule. The equations necessary to calculate the formation constant under conditions where more than one ligand is present in the solution and where the complex ion itself might be taken up by the ion exchanger are derived. It is shown that, under the experimental conditions employed, the necessary correction factors are relatively unimportant. (auth)

78

Argonne National Lab.

THE SYSTEM COBALTOUS CHLORIDE-WATER-ACETONE AT  $25^\circ\text{C}$ ; by Leonard I. Katzin and John R. Ferraro. Oct. 3, 1951. 12p. (AECU-1680; UAC-445)

A condensed version of this report was issued as report AECU-1178 and abstracted in Nuclear Science Abstracts as NSA 5-3032.

79

[Wisconsin Univ.]

THE SPECTROPHOTOMETRIC DETERMINATION OF THE RATE CONSTANT OF FIRST ORDER REACTIONS; by Edward L. King. [nd] 2p. (AECU-1700)

The report is reproduced here in its entirety.

The optical density of a solution in which the change  $A \rightarrow B$  is occurring is given by the equation  $D_t = \log(I_0/I) = l\{\epsilon_A(A)_t + \epsilon_B(B)_t\}$  where  $l$  is the cell length in cm,  $\epsilon_A$  and  $\epsilon_B$  are the molar extinction coefficients of A and B, and  $(A)_t$  and  $(B)_t$  are the molar concentrations at time  $t$ . If the rate law for this change is  $d(A)/dt = -k(A)$ , the dependence of  $D$  upon  $t$  is given by the equation  $\{D_t/l(A)_0 - \epsilon_B\} = (\epsilon_A - \epsilon_B)e^{-kt}$  and thus a plot of the logarithm of the quantity on the left side of the equation vs. time will give a straight line of slope  $-k$ . To make such a plot, however, requires knowledge of the quantities  $(A)_0$  and  $\epsilon_B$ . In a modification of the method suggested by Guggenheim (*Phil. Mag.* [7] 2, 538-43(1926)), the rate constant may be obtained without knowl-

edge of either of these two quantities. The equation relating the optical densities of the solution at times  $t$  and  $t + \tau$  is  $(D_t - D_{t+\tau}) = l(A)_0(1 - e^{-k\tau})(\epsilon_A - \epsilon_B)e^{-kt}$ , and it is seen that a plot of logarithm  $(D_t - D_{t+\tau})$  vs. time would give a straight line of slope  $-k$  if  $\tau$  is a constant time interval. In the usual procedure, readings of the optical density of the reaction mixture vs. a solvent "blank" would be made at times:  $t_1, t_2, \dots, t_n, t_1 + \tau, t_2 + \tau, \dots$ , and  $t_n + \tau$ . In view of the relationship:  $D' = (D_t - D_{t+\tau}) = \{\log I_0/I_t - \log I_0/I_{t+\tau}\} = \log(I_{t+\tau}/I_t)$ , a convenient means of determining the first-order rate constant is available. If, in the two cells in the usual arrangement for spectrophotometric measurements, there are placed two identical reaction mixtures in one of which the reaction has been proceeding for a time  $\tau$  longer than in the other, the value of the "optical density",  $D'$  of the less transparent sample compared with the more transparent sample is the value of the desired  $(D_t - D_{t+\tau})$ . A plot of logarithm  $D'$  vs.  $t$  will be a straight line of slope  $-k$ . As was true in the conventional Guggenheim method, the time interval  $\tau$  should be several times as great as the half time of the reaction in order to obtain optimum precision.

The foregoing considerations indicate a method for determination of the rate constant of a first-order reaction in which the extinction of a reacting system is measured against that of an identical mixture at a different stage of the same reaction. This method has advantages compared to the conventional Guggenheim method applied to a spectral study in which a solvent "blank" is used, in that fewer readings must be taken for the same number of points, the readings extend over a shorter time interval, and the readings need not be taken at planned time intervals. The somewhat larger slit widths which are required because of the absorption of the "blank" is a disadvantage in the study of reactions in which the rate of change of  $\epsilon$  values for reactant and/or product with changing wavelength is large.

80

Virginia Univ. Medical School

THE EFFECTS OF THYROXINE, 3,5-DIIODOTHYRONINE AND THYRONINE ON ASCORBIC ACID OXIDATION; [part of] THYROXINE AND DERIVATIVES ON ASCORBIC ACID OXIDATION; by Chalmers L. Gemmill. [nd] 18p. (AECU-1714)

Crystalline thyroxine and sodium-1-thyroxine pentahydrate accelerate the velocity of the uptake of oxygen in the ascorbic acid-ascorbic acid oxidase system. 3,5-Diiodothyronine has a slight effect on this system while thyronine has no effect in the concentrations used in these experiments. Crystalline thyroxine and sodium-1-thyroxine pentahydrate inhibit the velocity of uptake of oxygen in the ascorbic acid-cupric chloride system proportional to their concentration. The molar ratio of thyroxine to cupric chloride is approximately three. 3,5-Diiodothyronine had a slight effect on this system while thyronine had no effect. The mechanisms of these reactions are discussed in terms of a possible free radical formation of thyroxine. (auth)

81

Michigan Univ.

THE SYSTEM NICKEL(II) NITRATE-WATER-n-HEXYL ALCOHOL AT  $25^\circ\text{C}$ ; by Lyle K. Daly and Charles C. Templeton. Aug. 1, 1950. 11p. (AECU-1718; Report No. 2)



82

Michigan Univ.

THE SYSTEM THORIUM NITRATE-WATER; 20°C TO 160°C (Report No. 1); by Charles C. Templeton. Aug. 1, 1950. (AECU-1721)

The solubility of thorium nitrate in water has been determined from 20 to 160°C. The phase diagram is shown. A peritectic transition point occurs at 122°C.  $\text{Th}(\text{NO}_3)_4 \cdot 4\text{H}_2\text{O}$  is shown to be the solid phase in equilibrium with saturated solutions above 122°C. Although the hydrate below 122°C has generally been thought to be  $\text{Th}(\text{NO}_3)_4 \cdot 6\text{H}_2\text{O}$ , all the available data are much more in agreement with the formula  $\text{Th}(\text{NO}_3)_4 \cdot 5\frac{1}{2}\text{H}_2\text{O}$ . (auth)

83

Michigan Univ.

THE EFFECTS OF IMPURITIES ON THE SOLUBILITY OF SOME METALLIC NITRATE HYDRATES IN ORGANIC SOLVENTS (Report No. 3); by Charles C. Templeton. Aug. 1, 1950. 11p. (AECU-1722)

The solubilities of several grades of  $\text{Th}(\text{NO}_3)_4 \cdot 4\text{H}_2\text{O}$  in both commercial and purified *n*-hexyl alcohol and methyl-*n*-hexyl ketone have been determined. It is concluded that minor impurities in organic solvents for metallic nitrate hydrates apparently cannot change the solubility of the nitrate by any much greater percentage than their own molar percentage concentration in the organic solvent. The solubility of  $\text{Zn}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$  in mixtures of benzene and *n*-hexyl alcohol has been determined and lends additional support to the idea that this type of solubility involves a specific interaction between the metallic nitrate solute and the oxygen-containing grouping of the solvent molecule.

84

Michigan Univ.

THE ELECTRICAL CONDUCTANCE OF SOLUTIONS OF COBALT(II) NITRATE HEXAHYDRATE IN ACETOPHENONE AT 25°C; by Kurt H. Stern and Charles C. Templeton. Nov. 1, 1950. 15p. (AECU-1723; Report No. 5)

85

Brookhaven National Lab.

AN EXCHANGE STUDY OF TRIS (5,6-DIMETHYL 1, 10-PHENANTHROLINE) COMPLEXES OF FERROUS AND FERRIC IRON; by L. Eimer and A. I. Medalia. [nd] 25p. (BNL-1022)

Electron-transfer exchange reactions of ferrous and ferric phenanthroline have been studied by a tracer technique using  $\text{Fe}^{55}$  and  $\text{Fe}^{59}$ . The blue tris-ortho-phenanthroline complex of ferric ion (ferriin) was prepared by oxidation of the ferrous phenanthroline complex (ferroin) by lead dioxide in sulfuric acid medium. 5,6-Dimethyl-1,10-phenanthroline was used in 1N sulfuric acid because of the stability of both its ferrous and ferric complexes. Two methods were developed for separation of the ferrous and ferric complexes—precipitation of the ferrous form as perchlorate and extraction by means of camphor sulfonic acid (CSA) and chloroform. Several methods were investigated for recovery of the iron in the aqueous phase following extraction with chloroform-CSA. It is concluded that, with an extraction technique of separation, complete exchange is found between ferroin-5,6 and ferriin-5,6 within 15 sec at 0°C at concentrations of  $2.1 \times 10^{-5}$  formal in each species.

86

Ames Lab.

ZIRCONIUM IONS IN AQUEOUS SOLUTION; by Edgar

Harrison Dewell and Adolf F. Voigt. June 15, 1951. 37p. (ISC-146)

The ion-exchange properties of zirconyl chloride have been studied in solutions  $1.4 \times 10^{-3}\text{M}$  in Zr and 0.52M in ammonium chloride; the cationic content of the solutions was found to vary from 99% to about 55% as upper limits in the acid range  $1.62 \times 10^{-2}\text{M}$  to  $3.55 \times 10^{-3}\text{M}$ . A time dependency of the exchange of Zr was noted, and, in an attempt to discover its nature, conductance measurements at  $10^{-4}\text{M}$  Zr were made as time studies. Conductance curves were run at 25 and 35°C; unfortunately they were not subject to analysis in terms of the probable species present. At least three conducting species were present in the solutions and the measurements permitted the simultaneous observation of only two. The measurements are believed to be among the most accurate so far reported, and the concentrations investigated were much below the previous reports.

87

Southern Calif. Univ.

A STUDY OF THE EXCHANGE OF RADIOCYANIDE AND RADIOSULFIDE IONS WITH AQUEOUS THIOCYANATE ION; by Arthur M. Adamson and Philip S. Magee. [nd] 6p. (NP-3310)

Standard KSCN was mixed with  $\text{KC}^{14}\text{N}$  or  $\text{Na}_2\text{S}^{35}$ . After varying periods of time the thiocyanate, sulfide, and cyanide ions were separated and their activities were counted. The data are tabulated. No measurable exchange in either system was observed.

88

Cryogenic Lab., Ohio State Univ.

VAPOR PRESSURES OF INORGANIC SUBSTANCES; VIII. MOLYBDENUM BETWEEN 2151°K AND 2462°K; by James W. Edwards, Herrick L. Johnston, and Paul E. Blackburn. Oct. 29, 1951. 9p. (NP-3498; TR-281-12)

The vapor pressure of Mo has been determined by the vacuum evaporation method. Values have been calculated for the heat of sublimation at absolute zero and equations have been formulated for vapor pressure as a function of temperature. (auth)

89

Naval Research Lab.

THE PREPARATION OF HIGH PURITY SILVER CHLORIDE AND SILVER BROMIDE; by William Zimmerman, III. Oct. 24, 1951. 7p. (NRL-3879)

A procedure for the preparation of high-purity silver halides is described. For silver chloride the procedure involves reduction with zinc, solution of the metal in nitric acid, evaporation and separation of the mother liquor from the silver nitrate crystals, precipitation of silver chloride, solution in ammonium hydroxide, and crystallization from ammonium hydroxide solution. The procedure for silver bromide is similar with the substitution of hydrobromic acid for hydrochloric acid, and the elimination of the final crystallization from ammonia solution. The products obtained by this procedure are of high purity, with usually less than 0.005% metallic impurities.

90

Princeton Univ.

PROGRESS REPORT; JULY 1, 1951 - AUGUST 31, 1951; FUNDAMENTAL ANALYTICAL CHEMISTRY; by N. H. Furman. [nd] 10p. (NYO-792)

By using current densities of 0.6 to 0.9 amp/cm<sup>2</sup> the technique of electrolytic recovery of traces of Pb, Ni, Cd, and Zn from V was simplified. A technique for measuring

cathode potential which appears to offer an easy method of approximating the values of hydrogen overvoltages on Hg is described. Results of an investigation of the dependence of the extraction of vanadium cupferrate into chloroform on acid concentration are shown. A coulometric procedure for determination of microgram quantities of U is described and results of a series of such titrations are tabulated, comparing number of micrograms added to number of micrograms found.

91

Pittsburgh Univ.

PROGRESS REPORT FROM JULY 1, 1951, TO SEPTEMBER 30, 1951; by Robert Levine, Lloyd B. Barkley, Newton N. Goldberg, and Bruno M. Perfetti. Issued Oct. 10, 1951. 7p. (NYO-941)

Trifluoromethyl ethyl ketone, trifluoromethyl-n-propyl ketone, trifluoromethyl-n-amyl ketone, and -n-perfluoropropyl-n-propyl ketone were prepared by interaction of the appropriate alkyl phenyl ketone and fluorinated ester in the presence of commercial sodium methoxide. Ferric chloride and zinc chloride effectively catalyzed the acylation of acetophenone with acetic anhydride. Carbonation of the reaction mixture from picoline and phenyl lithium gave 2-phenyl-4-carboxymethylpyridine, and carbonation of the reaction mixture from lepidine and phenyl lithium gave 2-phenyl-4-methylquinoline.

92

Radiation Lab., Univ. of Calif.

GRIGNARD PREPARATION OF FLUORENE-2-CARBOXYLIC ACID (1); by D. C. Morrison. Oct. 19, 1951. 4p. (UCRL-1334)

A Grignard reagent was prepared from 2-bromofluorene by reaction with ethyl bromide and an excess of Mg. Carbonation of this reagent with dry ice produced fluorene-2-carboxylic acid. The acid was identified by permanganate oxidation of a portion to fluorenone-2-carboxylic acid.

93

Radiation Lab., Univ. of Calif.

SULFONATE ESTERS OF HALOGENATED PHENOLS IN GRIGNARD PREPARATIONS (1); by D. C. Morrison. Oct. 19, 1951. 7p. (UCRL-1505)

p-Benzenesulfonyloxybenzoic acid was prepared by reaction of benzenesulfonic acid p-bromophenyl ester and ethyl bromide with an excess of Mg, and carbonation with dry ice. Ethyl (p-toluenesulfonyloxyphenyl) phosphinic acid was prepared by the following steps: reaction of p-bromophenyl tosylate and ethyl bromide with an excess of Mg, addition of this solution to  $\text{POCl}_3$  in benzene, and hydrolysis by ice-hydrochloric acid. This acid was hydrolyzed with NaOH to ethyl (p-hydroxyphenyl) phosphinic acid.

94

ON PERIODICITIES IN THE ALKALI METAL GROUP.

G. G. Diogenov. *Doklady Akad. Nauk S.S.S.R.* 78, No. 5, 899-900(1951) June 11. (In Russian)

Heats of reaction of the 10 possible double decompositions of the fused hydroxides and nitrates of Li, Na, K, Rb, and Cs are tabulated and plotted according to periodic interval (i.e., Li-Na, Li-K, Li-Rb, etc.). The periodicity observed is discussed.

95

ELECTRON-MICROSCOPIC INVESTIGATION OF MUTUAL COAGULATION OF HYDROPHOBIC SOLS. A. V. Bromberg, V. M. Luk'yanovich, V. V. Nemtsova, L. V. Radushkevich, and K. V. Chmutov. *Doklady Akad. Nauk S.S.S.R.* 79, No. 2, 281-2(1951) July 11. (In Russian)

Observations on the coagulation of  $\text{V}_2\text{O}_5$  sols with Au,  $\text{Fe}(\text{OH})_3$ , and AgI sols are discussed briefly. 4 figures.

96

REGIONS OF CRYSTALLIZATION IN THE QUINARY RECIPROCAL SYSTEMS OF THE FLUORIDES, CHLORIDES, BROMIDES, AND IODIDES OF POTASSIUM AND SODIUM. A. G. Bergman, V. P. Radishchev, and N. S. Dombrovskaya. *Doklady Akad. Nauk S.S.S.R.* 77, No. 5, 811-13(1951) Apr. 11. (In Russian)

Partial phase diagrams in the form of triangular prisms are sketched for the fused-salt system  $\text{NaF-NaCl-NaBr-NaI-KF-KCl-KBr-KI}$  and for some of its segments of fewer components.

97

ON THE WIDTHS OF  $K_{\alpha}$  X-RAYS OF THE ELEMENTS  $_{37}\text{Rb}$  TO  $_{50}\text{Sn}$ . Bhaskar Gangadhar Gokhale. *Compt. rend.* 233, 937-9(1951) Oct. 22. (In French)

The widths, as determined with a bent-crystal spectrometer, of the  $K_{\alpha 1}$  and  $K_{\alpha 2}$  x rays of Rb, Sr, Y, Zr, Nb, Mo, Ru, Rh, Pd, Ag, Cd, In, and Sn are tabulated. The values are systematically and appreciably smaller than those reported by Allison (*J. Optical Soc. Am.* 18, 473(1929)). The width of the  $K_{\alpha 1}$  line increases with atomic number according to a  $Z^3$  law. Each  $K_{\alpha 2}$  line was found to be wider than the corresponding  $K_{\alpha 1}$  lines, thus contradicting the exception at Nb reported by Allison.

98

A POLAROGRAPHIC STUDY OF THE CADMIUM THIOCYANATE COMPLEXES. David N. Hume, Donald D. DeFord, and G. C. B. Cave. *J. Am. Chem. Soc.* 73, 5323-5(1951) Nov.

The half-wave potential of the cadmium ion was determined in potassium nitrate-potassium thiocyanate mixtures over the range of 0.1 to 2.0M thiocyanate at an ionic strength of 2.00. Application of a previously described method of mathematical analysis to the data revealed the existence of four reaction products:  $\text{CdSCN}^+$ ,  $\text{Cd}(\text{SCN})_2$ ,  $\text{Cd}(\text{SCN})_3^-$ , and  $\text{Cd}(\text{SCN})_4^{--}$  with formation constants of 11, 56, 6, and 60, respectively.

99

RECENT ADVANCES IN THE CHEMISTRY OF ZIRCONIUM AND HAFNIUM. Edwin M. Larsen. *J. Chem. Education* 28, 529-35(1951) Oct.

A brief review is made of the advances in the chemistry of Hf and Zr. The report is based on the production of Hf-free Zr, covering the aqueous chemistry of Zr, complex ion formation, precipitation and polymerization studies, and methods of separation. 31 references.

100

THE INFLUENCE OF MIXED SOLVENTS ON THE SOLUBILITIES OF SALTS. C. B. Monk. *J. Chem. Soc.*, 2723-6(1951) Oct.

The solubilities of several sparingly soluble iodates have been measured in various mixed solvents. The results indicate that the chemical character of the solvent is of major importance in influencing the decrease in solubility with decreasing dielectric constant of the solution. (auth)

# ANALYTICAL PROCEDURES

101

Oak Ridge National Lab.

APPLICATION OF ION-EXCHANGE METHODS TO THE QUANTITATIVE ANALYSIS OF SUGARS IN PLANT EXTRACTS (abstract); by G. R. Noggle and L. P. Zill. [nd] 1p. (AECU-1683)

The report is reproduced here in its entirety.

Details are given for an analytical scheme of determining quantitatively the sugars in plant extracts. The sugars are extracted from plant material in 80% ethanol. Following removal of the alcohol the extract is then passed through



either a mixed bed of cation- and anion-exchange resin or successively through a cation resin and an anion resin. In either case the sugars pass through and are collected in the effluent solution. The sugar solution is then treated with potassium tetraborate which complexes (see previous paper by Khym and Zill) the sugars and enables one to separate them by conventional ion-exchange techniques. The results from the analyses of several plant extracts are presented.

The method is particularly valuable for tracer studies with  $C^{14}$ . Results are given showing total and specific activities of a number of sugars prepared by biosynthetic procedures. (Paper presented at American Society of Plant Physiologists, AIBS, September 1951, Minneapolis.)

102

Michigan Univ.

THE DISTRIBUTION OF SEVERAL BIVALENT AND TRIVALENT METALLIC NITRATES BETWEEN WATER AND  $n$ -HEXYL ALCOHOL AT 25°C (Report No. 4); by Charles C. Templeton and Lyle K. Daly. Sept. 1, 1950. 29p. (AECU-1724)

103

Brookhaven National Lab.

ANALYSIS OF URINE FOR GROSS RADIOACTIVITY; Frederick P. Cowan and Jerome Weiss. Oct. 1, 1951. 11p. (BNL-1000)

The utility of simple evaporation and counting of a urine sample for ascertaining whether radioactive materials have entered the body has been investigated. The removal of K by precipitation with cobaltinitrite increases the sensitivity of the method by a factor of 10. The removal of urea by a method involving the action of nitrous acid decreases the amount of solids and consequently the amount of self-absorption. By this method a range of activity in the first day's elimination that can be considered unimportant can usually be established. For higher levels quantitative urinalysis must be made.

104

Brookhaven National Lab.

THE CHEMICAL ANALYSIS AND ISOTOPIC ASSAY OF ORGANIC COMPOUNDS; by R. Christian Anderson, Yvette Delabarre, and Aksel A. Bothner-By. 25p. [nd] (BNL-1001)

A simple, rapid and accurate method has been developed for the concomitant chemical analysis and isotopic assay of single micro samples of organic compounds. The procedure, modified from the one described by Naughton and Frodyma, consists of the combustion of the sample at about 750°C and one atmosphere of oxygen with the subsequent removal, by condensation, of the carbon dioxide and water from the oxygen carrier at reduced pressures. The carbon dioxide and water are vaporized separately and determined manometrically. The carbon dioxide is then either sublimed into a gas-counting tube, converted to barium carbonate or transferred to a bulb for use in a mass spectrometer as required for assay. The water formed can be used for deuterium assay by a slight modification in the method. (auth)

105

Hanford Works

THE QUANTITATIVE SEPARATION OF AMERICIUM FROM PLUTONIUM AND URANIUM; by H. W. Miller. Oct. 15, 1951. 17p. (HW-22267)

The procedure described for the separation and determination of Am and Pu in solutions containing Am, Pu, and U is based on the fact that ceric ion will oxidize plutonium quantitatively to the plutonyl ion and that the subsequent

addition of HF results in the partial precipitation of ceric fluoride which carries americium trifluoride quantitatively. This precipitate is mounted for counting. Treatment of the supernatant, containing the uranyl and plutonyl ion, with hydroxylamine hydrochloride results in the reduction of both the ceric and the plutonyl ions and the subsequent entrainment of Pu with the very insoluble cerous fluoride. The uranyl ion remains in solution and is discarded while the precipitate obtained is mounted for the determination of Pu by counting methods. The theory and limitations of the procedure are discussed.

106

Knolls Atomic Power Lab.

THE MICRODETECTION OF CARBON; by L. P. Pepkowitz. June 4, 1951. 12p. (KAPL-636)

The method of microdetection of carbon described is a convenient modification of the original Emich procedure. The apparatus is simply a T-tube constructed from 4-mm tubing. The microsample is burned in an atmosphere of oxygen and the resulting  $CO_2$  absorbed in  $Ba(OH)_2$ . The formation of the characteristic  $BaCO_3$  crystals is specific for carbon. As little as 0.1  $\mu g$  of carbon can be detected with a magnifying glass. This test has proved to be applicable to all materials, inorganic or organic, tested to date except carbonates. The total time for the test is 10 min. A modification of the method is described for handling carbonates in pyrex tubing. (auth)

107

Knolls Atomic Power Lab.

THE MICRODETECTION OF SULFUR; by L. P. Pepkowitz and E. L. Shirley. June 4, 1951. 14p. (KAPL-638)

The method described for the microdetection of sulfur, though somewhat less sensitive than the azide-iodine test, is a universal method applicable to sulfur in any form including sulfate, sulfide, or elemental sulfur. The test is sensitive to 0.5  $\mu g$  of sulfur and is simpler than the usual potassium fusion, azide-iodide procedure for sulfide. The total sulfur in the sample is reduced to  $H_2S$  by a reducing mixture composed of HI, HCl, and  $H_3PO_2$ . The  $H_2S$  is absorbed in a molybdate-thiocyanate solution, and the appearance of a red color indicates the presence of sulfur.

108

Cornell Univ.

TOPICS TO INVESTIGATE THE STRUCTURE OF SOME BORANES AND RELATED COMPOUNDS BY ELECTRON DIFFRACTION; OCTOBER 1946-JUNE 1948; TO DEVELOP QUANTITATIVE PROCEDURES FOR ESTIMATING ELECTRON DIFFRACTION INTENSITIES; JUNE 1948-SEPTEMBER 1949; FINAL REPORT. Mar. 1, 1950. 48p. (NP-3483; U-17394)

109

Department of Mines and Technical Surveys (Canada)

THE DETERMINATION OF NaOH IN THE PRESENCE OF LARGE QUANTITIES OF  $Na_2CO_3$  USING pH TO DETERMINE THE END POINT (Topical Report No. TR-91/51); by H. J. Herbst. Oct. 4, 1951. 4p. (NP-3492)

A method is described for the determination of NaOH in the presence of large quantities of  $Na_2CO_3$ , using pH to determine the end point. The use of  $BaCl_2$  solution to precipitate  $Na_2CO_3$  present is suggested.

110

Carbide and Carbon Chemicals Co., Y-12

GAS ANALYSIS FOR CARBON DIOXIDE, HYDROGEN, AND OXYGEN; by Frances L. Sachs. Oct. 23, 1951. 73p. (Y-B4-45)

A bibliography on gas analysis.

111

Oak Ridge National Lab. and Miller School of Biology, Univ. of Virginia  
 IODINE DISTRIBUTION IN ANURA LARVAE (abstract); by James Norman Dent and Ernest L. Hunt. [nd] 1p. (AECU-1708)

The report is reproduced here in its entirety.

Tadpoles of *Hyla versicolor* were immersed in spring water to which  $I^{131}$  had been added. At the end of 24 hr animals were removed, washed, and transferred to spring water containing no radioactive iodine. After varying periods of time following this treatment specimens were fixed and sectioned. Contact autoradiograms of the sections showed iodine consistently localized in the thyroid, thymus, horny teeth, chromatophores, and in the pigmented layer of the eye. Relatively light radioactivity was occasionally seen in the prosepheos, gills, liver, and epithelium. Apparently the intestine was very active in the elimination of iodine since  $I^{131}$  was concentrated throughout that organ in animals killed one day after iodine administration but disappeared within ~12 days, the posterior region retaining radioactivity after it had been lost in the anterior. Fragmentary observations made on a few larvae of *Rana pipiens*, *R. palustris*, and *Bufo americanus* treated in the same fashion gave similar results. (auth)

112

THE UPTAKE OF  $P^{32}$  BY RIBONUCLEOTIDES IN LIVER-CELL FRACTIONS. J. N. Davidson, W. M. McIndoe, and R. M. S. Smellie. *Biochem. J.* 49, 36(1951) Aug.

The method for the separation of ribonucleotides by ionophoresis from the ribonucleic acid fraction in the Schmidt & Thannhauser separation scheme was applied to isolated nuclei and cytoplasmic fractions from the liver tissue of adult rats which had received 20  $\mu$ c/100g of  $P^{32}$  2 hr prior to killing. Results show the activity of the nuclear RNA (ribonucleic acid) is much greater than that of the RNA in any cytoplasmic fraction. Of the cytoplasmic RNA fractions the activity is lower in the small granules than in the large granules or cell sap. Uridylic acid in the cytoplasmic RNA fractions showed a higher activity than did the other nucleotides, and in nuclear RNA adenylic acid showed the greatest activity. The phosphoprotein phosphorus in all fractions showed a very high activity. In the cytoplasmic fractions it was accompanied by small amounts of a nonnucleotide organic phosphate fraction which appeared to consist in part of ethanolamine phosphate.

113

ZIRCONIUM—ITS ESTIMATION AND DETERMINATION IN ZIRCON. C. Lakshman Rao, M. Venkataramaniah, and Bh. S. V. Raghava Rao. *J. Sci. Ind. Research (India)* 10B, 152-4(1951) July.

Benzoic acid precipitates Zr, quantitatively in 0.15N HCl solution, and quantities as small as 0.5 mg of  $ZrO_2$  in 100 cc can be estimated; quantities up to 0.3 mg in 100 cc can be detected. The presence of Be, Mn, Zn, Ni, Co, Cu,  $UO_2^{++}$ , Al, and rare-earth elements does not interfere.

#### ATOMIC WEIGHTS AND PERIODIC SYSTEMS

114

A TABLE OF MENDELEEV'S PERIODIC SYSTEM OF THE CHEMICAL ELEMENTS BASED ON THE ELECTRONIC STRUCTURE OF THE ATOM. V. L. Al'banskiĭ. *Zhur. Obshcheĭ Khim.* 21(83), 1393-5(1951) Aug. (In Russian)

The lanthanides and actinides are arranged vertically in group III of this table to indicate more clearly their chemical nature. A few elements, such as Th, Pa, and U, appear in two locations corresponding to their principal

types of chemical behavior. Md is used as the symbol for element 97.

#### CRYSTALLOGRAPHY AND CRYSTAL STRUCTURE

115

North American Aviation, Inc.  
 ON THE ORDERING KINETICS IN AuCu; by D. Bowen. Issued Oct. 31, 1951. 16p. (NAA-SR-154)

The ordering kinetics in the superlattice alloy AuCu has been examined in the light of some recent information. A new formulation of the relationship between long range order parameter and resistivity has been made, and the annealing kinetics of resistivity studied using this formula. It was found that the rate equation most adequately describing the data, in terms of the present formulation, was of fourth order, which implies a cooperation of two Cu and two Au atoms in the ordering process. This result is in agreement with that obtained in the annealing kinetics of cold work in Cu, but at variance with a previous study of the ordering kinetics in this AuCu system. It appears that new, better, data are needed to decide between the present formulation and that presented in a previous kinetic study of AuCu. The ring diffusion mechanism of Zener may be the rate controlling process in this reaction, and thus would favor the fourth order over the third order. (auth)

116

Pennsylvania State Coll. School of Mineral Industries  
 RECRYSTALLIZATION AND MELTING OF SIMPLE CRYSTALS; OFFICE OF NAVAL RESEARCH (Technical Reports Nos. 36, 37, 38); by W. A. Weyl and D. P. Enright. Aug. 1951. 76p. (NP-3456)

Separate abstracts have been prepared on the following sections comprising this report: The Mechanism of Recrystallization and of Sintering, Report No. 36; Atomistic Approach to the Melting of Simple Ionic Crystals, Report No. 37; and Atomistic Approach to the Formation of Eutectics between Simple Binary Compounds, Report No. 38.

117

Pennsylvania State Coll. School of Mineral Industries.  
 THE MECHANISM OF RECRYSTALLIZATION AND OF SINTERING, Report No. 36 of RECRYSTALLIZATION AND MELTING OF SIMPLE CRYSTALS; OFFICE OF NAVAL RESEARCH TECHNICAL REPORTS NOS. 36, 37, 38; by W. A. Weyl and D. P. Enright. Aug. 1951. (NP-3456 (Report No. 36))

Sintering or recrystallization of ZnO can be enhanced by selecting a slightly reducing atmosphere which enhances the formation of  $Zn^+$  ions and, with it, the formation of lattice vacancies. It has been found that the number of vacant lattice sites can be decreased if foreign ions are introduced into the ZnO which have a threefold positive charge and which are suitable for occupying a lattice site that is normally occupied by a  $Zn^{++}$  ion.  $Ga^{+3}$  and  $In^{+3}$  were the most effective impurities in this respect. Their outer electron shell closely resembles that of the  $Zn^{++}$  ion. However, even  $Al^{+3}$  ions have some retarding effect on the sintering of ZnO at 1000°C in air. Experiments are reported which illustrate the effect of foreign cations with threefold positive charge upon the sintering process of ZnO. The  $Ga^{+3}$  ions, for example, make it possible for the ZnO lattice to accommodate an equal number of  $Zn^+$  ions without releasing  $O^{--}$  ions. Thus, the tendency of the normal cation to accept electrons can be met without producing vacancies. As a result,  $Ga_2O_3$  retards sintering. This phenomenon is not restricted to ZnO, but it can be shown that the addition of  $Sb_2O_5$  retards sintering whereas the addition of CuO enhances this process. MgO was included in the experiments to show the drastic difference which exists between MgO and ZnO. The behavior of MgO makes it



obvious that the surface of a periclase crystal cannot consist of an alternate array of  $\text{Mg}^{++}$  and  $\text{O}^{--}$  ions. The resulting  $\text{MgO}$  is a fluffy powder, and it is extremely difficult to compress into a nonporous ceramic body and to sinter the pure oxide at a temperature below  $1800^\circ\text{C}$  within a reasonable time.

118

Pennsylvania State Coll. School of Mineral Industries. ATOMISTIC APPROACH TO THE MELTING OF SIMPLE IONIC CRYSTALS; by W. A. Weyl, Report No. 37 of RECRYSTALLIZATION AND MELTING OF SIMPLE CRYSTALS; OFFICE OF NAVAL RESEARCH TECHNICAL REPORTS NOS. 36, 37, 38, by W. A. Weyl and D. P. Enright. Aug. 1951. (NP-3456 (Report No. 37))

The sudden breakdown of the structure of  $\text{NaCl}$  at its melting point is attributed to the passing of  $\text{Na}^+$  ions past one another without screening of their positive electrical fields by  $\text{Cl}^-$  ions. The resulting  $\text{Na}^+ - \text{Na}^+$  repulsion leads to the formation of a "hole" and the depth action of this disturbance causes other  $\text{Na}^+$  ions to cooperate and thus produces the collapse of the lattice. Based on the assumption that the cation-cation repulsion represents a major factor in melting, it is possible to correlate the melting temperatures of simple compounds with the polarizabilities of their cations. (auth)

119

Pennsylvania State Coll. School of Mineral Industries. ATOMISTIC APPROACH TO THE FORMATION OF EUTECTICS BETWEEN SIMPLE BINARY COMPOUNDS; by W. A. Weyl (Report No. 38 of RECRYSTALLIZATION AND MELTING OF SIMPLE CRYSTALS; OFFICE OF NAVAL RESEARCH TECHNICAL REPORTS NOS. 36, 37, 38 by W. A. Weyl and D. P. Enright). Aug. 1951. (NP-3456 (Report No. 38))

In NP-3456 (Report No. 37) the repulsion between  $\text{Na}^+$  ions in close proximity is made responsible for the melting of  $\text{NaCl}$  and of similar simple compounds. This concept is used in the present report to explain the formation of eutectic melts and to estimate the degree of participation of each component in the formation of binary eutectics of simple compounds. It can be shown that the eutectic mixture contains the most polarizable ion in the highest concentration. A eutectic mixture of  $\text{NaF}$  and  $\text{NaI}$  contains more  $\text{NaI}$  molecules than  $\text{NaF}$  molecules. An eutectic mixture of  $\text{RbCl}$  and  $\text{NaCl}$  contains more  $\text{RbCl}$  than  $\text{NaCl}$ , but one of  $\text{RbCl}$  and  $\text{AgCl}$  contains more  $\text{AgCl}$  than  $\text{RbCl}$ , because the nonnoble gas-like  $\text{Ag}$  has the highest polarizability. (auth)

120

Massachusetts Inst. of Tech. STRUCTURE OF DIBORIDES OF TITANIUM, ZIRCONIUM, COLUMBIUM, TANTALUM, AND VANADIUM; by John T. Norton, H. Blumenthal, and S. J. Sindeband. [nd] 14p. (NP-3477; U-17357)

A study was made of the structure of the borides of Nb, Ta, Ti, V, and Zr. The compounds were found to correspond to the formula  $\text{MeB}_2$  and have isomorphous crystal structures with the metal atoms arranged in a simple hexagonal lattice having an axial ratio slightly greater than unity. The unit cell was found to contain one molecule of  $\text{MeB}_2$ , corresponding to alternate layers of metal and boron atoms, parallel to the basal plane of the lattice. The borides all were found to have well-developed metallic properties.

121

STRUCTURES OF URANIUM. J. Thewlis. *Nature* 168, 198(1951) Aug. 4.

Results of x-ray examination of U at high temperatures are outlined. Unit-cell dimensions of  $\alpha$ ,  $\beta$ , and  $\gamma$  uranium and of U + 1.4% Cr are tabulated and discussed in comparison with previously reported values.

## DEUTERIUM AND DEUTERIUM COMPOUNDS

122

THE EXCHANGE OF DEUTERIUM FOR HYDROGEN IN *n*-HEPTANE. Joseph A. Dixon and Robert W. Schiessler. *J. Am. Chem. Soc.* 73, 5452-3(1951) Nov. (Notes)

Results of experiments to measure exchange of D for H between  $\text{D}_2\text{O}$  and *n*-heptane with various catalysts are tabulated. No exchange was observed in the liquid phase with Ni and Pt catalysts. Exchange takes place in vapor phase over a kieselguhr-supported Ni catalyst. Exchange proceeded at  $135^\circ$  in the vapor phase and did not take place at  $150^\circ$  in the liquid phase. The exchange is accompanied by scission of carbon-carbon bonds and consequent alteration of the hydrocarbon skeleton.

## FLUORINE AND FLUORINE COMPOUNDS

123

Radiation Lab., Univ. of Calif.

THE VAPOR PRESSURE OF AMERICIUM TRIFLUORIDE (thesis); by Merle Eugene Jones. Aug. 1951. Decl. Nov. 9, 1951. 35p. (AEC-D-3270; UCRL-1438)

The vapor pressure of  $\text{AmF}_3$  has been measured by the method of molecular effusion in the temperature range of  $800$  to  $1200^\circ\text{C}$ . The values obtained fit the equation  $\log p = 10.89 - (20030/T)$  very well. A  $\Delta H_0$  of sublimation of  $109.4$  kcal/mole was calculated from the measured vapor pressures assuming  $\Delta C_p = -14$  eu. This value for  $\Delta C_p$  was also used in the calculation of the free energy of sublimation equation:

$$\Delta F = 109,400 - 2.3(-14)T \log T - 151.1 T. \text{ (auth)}$$

124

Argonne National Lab.

NOTE ON THE ELECTRON AFFINITY OF FLUORINE; by Richard B. Bernstein and Max Metlay. Oct. 3, 1951. 2p. (AECU-1679; UAC-444)

The report is reproduced here in its entirety.

It seems advisable to reconsider the available facts regarding the electron affinity of the fluorine atom in the light of the recent definitive value for the heat of dissociation of fluorine,  $37.7 \pm 0.4$  kcal/mole, obtained by Doescher (*J. Chem. Phys.* 19, 1070(1951)). Evans, Warhurst, and Whittle (*J. Chem. Soc.*, 1524(1950)) pointed out clearly that the electron affinity calculated by Mayer and Helmholtz (*Z. Physik* 75, 19(1932)) using the Born-Haber cycle was dependent on the particular choice of  $D(\text{F}_2)$  employed.

The early value of  $63.5$  kcal/mole had been used to obtain the now "accepted" value of  $95.3$  kcal/mole for the electron affinity of fluorine, which is the average result based on calculations for each of the various alkali-metal fluorides. Employing the new dissociation energy gives a corrected value of  $95.3 - \frac{1}{2}(63.5 - 37.7) = 82.4$  kcal/mole for the affinity.

An experimental study to determine the electron affinity of fluorine has been reported by Metlay and Kimball (*J. Chem. Phys.* 16, 779(1948)). The results were considered anomalous at the time for two reasons: First, the apparent electron affinity showed a trend with temperature over and above the random scatter in the data. Second, the numerical values obtained were considerably lower than the expected value of  $95$  kcal/mole.

The observed trend was attributed to incomplete dissociation of fluorine on the hot, fluoride-coated tungsten filament, i.e., an accommodation coefficient for dissociation of less than unity. This conclusion no longer appears tenable. It is possible that both the large scatter in the data and the apparent temperature effect may be due to the considerable experimental difficulties encountered with such measurements on fluorine.

The mean value of their results (27 observations) is 82.2 kcal/mole, (a.d. =  $\pm 3.9$  kcal/mole). This is in good agreement with the calculated value of 82.4 kcal/mole as stated above. In the absence of a more reliable experimental determination this would appear to be the best available estimate for the electron affinity of fluorine.

125

Argonne National Lab.

THE EXCHANGE OF RADIOACTIVE FLUORINE BETWEEN HYDROGEN FLUORIDE AND INTERHALOGEN COMPOUNDS; by Max T. Rogers and Joseph J. Katz. Feb. 16, 1951. 23p. (ANL-4711)

Data show that exchange of radioactive  $F_2$  between anhydrous HF and interhalogen compounds occurs rapidly with the liquid compounds  $BrF_3$ ,  $ClF_3$ ,  $BrF_5$ , and  $IF_5$ , and with the gaseous compounds  $ClF_3$ ,  $BrF_3$ , and  $IF_3$ , and that fairly stable complexes are being formed. Data on exchange of F between  $ClF_3$  and the solid fluorides  $NaHF_2$  and  $NaF$  are tabulated. The Cu apparatus used is illustrated. It is shown that no exchange occurs between HF and  $SF_6$  or  $CCl_2F_2$ , where such complexes are unlikely, but that rapid exchange occurs between HF and  $SbF_5$  or  $BF_3$ , where such complexes are highly probable from other experiments. Convenient methods have been developed for counting radioactive fluorine in the form of gaseous fluorides, using commercially available counters, and apparatus has been devised and built for handling interhalogen compounds in fluorothene and Teflon equipment.

126

Bureau of Mines

DECOMPOSITION TEMPERATURES OF POLYTETRAFLUOROETHYLENE AND POLYMONOCHLOROTRIFLUOROETHYLENE AS INDICATED BY HALOGEN LIBERATION; by H. A. Watson, H. J. Stark, L. E. Sieffert, and L. B. Berger. Dec. 1950. 12p. (BM-RI-4756)

Polytetrafluoroethylene liberated fluorine when heated to 350°C or higher, the rate of evolution showing a sharp increase between 400 and 450°C. Three grades of polymonochlorotrifluoroethylene liberated fluorine and chlorine at temperatures above 250°C, the rate of evolution increasing markedly above 300°C. At the highest test temperatures, 325 to 328°C, these gases were evolved in quantities proportional to the molecular composition of the polymer; at lower temperatures, chlorine appeared to be detached more readily from the molecule. Under practical conditions of use, the decomposition products of both materials may be considered as consisting mainly of HF and HCl, as the evolved fluorine and chlorine would react with atmospheric moisture.

127

ON THE PROPERTIES OF FLUOROCARBON AND POLYSILOXANE FLUIDS. A. Bondi. *J. Phys. & Colloid Chem.* 55, 1355-68(1951) Nov.

The intermolecular force constants of a fluorocarbon and of several polysiloxanes were calculated from their respective polarizability and diamagnetic susceptibility data. The exceptional smallness of the latter constants appears to be due to the large fraction of ionic bonding in these compounds as compared to the bonding in other organic molecules. For these liquids  $(\partial E/\partial V)_T/(\Delta E_v/V) \sim 1.3$  and not 1, as for "normal" liquids. A relation between thermal conductivity and the pressure coefficient of viscosity is described.

128

ON THE SECOND AND THIRD VIRIAL COEFFICIENT OF METHYL FLUORIDE. R. J. Lunbeck and C. A. Ten Seldam. *Physica* 17, 788-92(1951) Aug.

Because of the polar character of methyl fluoride its virial coefficients cannot be described by a formula of the

Lennard-Jones type for the molecular interaction. On extending this formula with a term, representing the dipole interaction, a good agreement was found between experimental and calculated values of the second and third virial coefficients. Only two constants had to be determined, the third constant occurring in the formula for the intermolecular field was taken from dielectric constant measurements. (auth)

129

PERFLUORO-*n*-PROPYL DISULFIDE AND PERFLUORO-*n*-PROPYL TRISULFIDE. Murray Hauptschein and Aristid V. Grosse. *J. Am. Chem. Soc.* 73, 5461-3(1951) Nov. (Notes)

Perfluoro-*n*-propyl disulfide and perfluoro-*n*-propyl trisulfide were prepared by reaction of molten sulfur with 1-iodoheptafluoropropane under pressure at 250°. The infrared spectra of both compounds are shown, and their physical properties are tabulated.

130

PREPARATION OF ORGANOFUROSILANES USING AQUEOUS HYDROFLUORIC ACID. N. S. Marans, L. H. Sommer, and F. C. Whitmore. *J. Am. Chem. Soc.* 73, 5127-30(1951) Nov.

A series of organofluorosilanes has been prepared in 60 to 95% yield by reaction of the corresponding organoalkoxy-silanes and trialkylchlorosilanes with aqueous hydrofluoric acid.

131

DIPOLE MOMENT, INDUCTION AND STRUCTURE IN FOUR FLUORINE SUBSTITUTED MOLECULES. Julian H. Gibbs and Charles P. Smyth. *J. Am. Chem. Soc.* 73, 5115-18 (1951) Nov.

In order to investigate the possible effect of chain-branching in a molecule upon bond polarity and the effects of induction upon structure, the dielectric constants of four fluorine-substituted compounds are measured over a range of temperature and pressure in the vapor state and used to calculate the molecular dipole moments. The moments found are *n*-perfluoropentane, 0; isoperfluoropentane, 0; 1,1-difluoroethane,  $2.24 \times 10^{-18}$ ; trifluoroacetic acid,  $2.28 \times 10^{-18}$ . Large atomic polarizations of 8.5 cc are found for the two perfluorocarbons. The zero moment of *n*-perfluoropentane parallels the zero moments of the saturated hydrocarbons, and that of isoperfluoropentane shows that there is no measurable difference in polarity between a carbon-fluorine bond on a tertiary carbon and one on a primary carbon. The moments of 1,1-difluoroethane and trifluoroacetic acid agree with values calculated by vector addition.

132

ADDITION COMPOUNDS OF PERFLUORO FATTY ACIDS WITH ETHERS AND TERTIARY AMINES. Murray Hauptschein and Aristid V. Grosse. *J. Am. Chem. Soc.* 73, 5139-41(1951) Nov.

Perfluoro fatty acids have been found to react with ethers and tertiary amines to form stable addition compounds. Various physical and chemical properties of the representative examples  $3CF_3CO_2H \cdot 2(C_2H_5)_2O$ ,  $2C_3F_7CO_2H \cdot (C_2H_5)_2O$ ,  $3C_3F_7CO_2H \cdot 2$  dioxane,  $3CF_3CO_2H \cdot 2C_6H_5N(CH_3)_2$ , and  $5C_3F_7CO_2H \cdot 3C_6H_5N(CH_3)_2$  are described. (auth)

133

THE FLUORINATION OF SOME VOLATILE CHLORIDES WITH AMMONIUM FLUORIDE. C. J. Wilkins. *J. Chem. Soc.*, 2726-8(1951) Oct.

Halogen exchange occurs when ammonium fluoride is heated with certain volatile chlorides. In some cases useful yields of monofluoride chlorides may be obtained without special control of the conditions. (auth)



134

THE FLUORINATION OF SOME NITRIDES AND CYANIDES. G. E. Coates, J. Harris, and T. Sutcliffe. *J. Chem. Soc.*, 2762-3(1951) Oct.

Experiments on the fluorination of a few nitrides and cyanides are reported. Details of the fluorination of hydrogen cyanide and trifluoromethyl cyanide using cobalt fluoride and especially constructed apparatus are given.

#### LABORATORIES AND EQUIPMENT

135

Atomic Energy Research Establishment, Harwell, Berks (England)

A FURNACE FOR THE STUDY OF CHEMICAL REACTIONS BETWEEN GASES AND SOLIDS IN THE HARWELL PILE; by M. Tomlinson and J. Wright. Apr. 9, 1951. 13p. (AERE-C/R-699)

A platinum-wound silica tube furnace for the investigation of gas-solid reactions in the Harwell pile has been designed, built and tested and found to operate satisfactorily over the required working range. The maximum power input to the furnace is 500 watts. Temperatures up to 550°C have been maintained uniform to  $\pm 0.5^\circ\text{C}$  throughout a 4 in. long by  $\frac{1}{2}$ -in. diam solid sample, and held constant in time to  $\pm 2^\circ\text{C}$  in an air-stream of 2 liters/min. A similar furnace of about 1600 watts maximum power consumption has been prepared, and is expected to give temperatures up to 1000°C. (auth)

#### MOLECULAR STRUCTURE

136

Gates and Crellin Labs. of Chemistry, Calif. Inst. of Tech. INVESTIGATIONS OF THE MOLECULAR STRUCTURES OF CERTAIN COMPOUNDS OF BORON BY THE METHOD OF ELECTRON DIFFRACTION (Technical Report No. 1); by Kenneth Hedberg and Verner Schomaker. Apr. 1, 1951. 38p. (NP-3482; U-17366)

The molecular structures of the following compounds were studied by the electron-diffraction method: stable pentaborane, tetrachlorodiborane, boron trichloride, bromodiborane, dimethylaminodiborane, aminodiborane, tetramethyldiborane, 1,1-dimethyldiborane, trisilylamine, tetraborane, and unstable pentaborane. Results of the studies are tentative and are therefore presented without discussion.

137

CORRELATION BETWEEN FREQUENCIES OF ISOTOPIC MOLECULES (SUMMATION RULE). L. M. Sverdlov. *Doklady Akad. Nauk S.S.S.R.* 78, No. 6, 1115-18(1951) June 21. (In Russian)

A formula equating the sum of squares of fundamental frequencies of a compound and its totally deuteriated form with that of its partially deuteriated forms is derived. Its use is illustrated with the normal and deuteriated forms of  $\text{H}_2$ ,  $\text{C}_2\text{H}_2$ ,  $\text{CH}_4$ ,  $\text{C}_2\text{H}_4$ ,  $\text{C}_2\text{H}_2\text{Br}_2$ , and  $\text{C}_6\text{H}_6$ .

138

TOWARD A THEORY OF THE MAIN X-RAY ABSORPTION EDGES OF ATOMS IN MOLECULES. E. E. Vainshtein, R. L. Barinskii, and K. I. Narbutt. *Doklady Akad. Nauk S.S.S.R.* 77, No. 6, 1003-6(1951) Apr. 21. (In Russian)

Calculation of the exact x-ray absorption profile in the region of the main absorption edges is discussed briefly.

#### RADIATION CHEMISTRY

139

RETENTION OF  $\text{Br}^{80}$  IN COMPLEX BROMIDES, FOLLOWING ISOMERIC TRANSITION. Arthur W. Adamson and Jean M. Grunland. *J. Am. Chem. Soc.* 73, 5508(1951) Nov. (Communication to the editor)

Experiments which show high retention of  $\text{Br}^{80}$  by aqueous bromoplatinate(IV) ions following isomeric transition and disruption of the bromopentamminecobaltate(III) ion upon every isomeric transition led to the tentative conclusion that the degree of reactivity induced by isomeric transitions is strongly dependent upon the charge of the parent molecule.

#### RADIATION EFFECTS

140

Oak Ridge National Lab.

FURTHER INVESTIGATIONS OF THE INHERITANCE OF REDUCED VIGOR (abstract); by R. F. Kimball and R. P. Geckler. [nd] 2p. (AECU-1682)

The report is reproduced here in its entirety.

Considerable evidence has been obtained by Kimball and by Geckler that reduced vigor after autogamy in the progeny of irradiated or nitrogen mustard treated paramecia is the result of mutational changes in the micronuclei. However, Kimball and more particularly Geckler have reported a number of exceptions to expectation on the simple mutation hypothesis. Among those exceptions is the fact that the two members of conjugant pairs of crosses between treated and untreated paramecia often fail to yield identical autogamous progeny. Two possible interpretations of such differences appear possible: (1) they may result from differences between the two members existing prior to conjugation and presumably inherited cytoplasmically or (2) they may arise after conjugation in the separate lines of descent from two members. In the latter case, there are three alternatives: (1) the changes result from spontaneous mutations in the micronuclei; (2) they result from spontaneous alterations in nonmicronuclear components of the hereditary mechanism; or (3) they result from entirely ephemeral differences between different autogamous cultures and are not inherited at all. Investigations were made of a stock cross in variety 4 which resulted in considerable reduced vigor at the autogamy following conjugation. It seemed reasonable to believe that an investigation of this cross would give information on at least one form which radiation-induced effects might take. It was found that (1) the reduced vigor is subject to significant variation within clones; (2) the magnitude of this variation is probably sufficient to account for apparent differences between pair members; (3) the reduced vigor and the variation in it occurs equally in the exconjugant clones descended from the two parental stocks. Thus it seems unlikely that the condition of the animals prior to conjugation has anything to do with the differences between the members afterwards and so the variation that is found is to be attributed to conditions arising after conjugation. Of the three alternatives mentioned for this case, the third one can be ruled out since two cultures from sister animals separated from each other by only a few divisions regularly give rise to autogamous progeny in which the same per cent are of reduced vigor although when they are separated by many divisions this is not so. A somewhat similar variation between animals separated by many divisions was found in stock 90 animals which had been x irradiated. Two lines of descent from an irradiated animal frequently gave rise to different percentages if they had been separated for some time prior to autogamy. In both this case and the stock cross in variety 4, a decision cannot be made between the alternatives of spontaneous nuclear mutations and of spontaneous cytoplasmically inherited variation. However, in stock 90, spontaneous mutation would have to be either more frequent in the x-irradiated material than in the controls or more readily detected to account for the results. (Paper presented at Paramecium Genetics Symposium, Sept. 1951, Bloomington, Ind.)

141

POLYMERIZATION BY MEANS OF HIGH-ENERGY ELECTRONS. S. Loewe. *Science* **114**, 555-6(1951) Nov. 15.

Cathode rays and electron beams caused polymerization of organic substances present as thin films on glass surfaces. The experiments seemed to indicate that saturated compounds are readily polymerized.

142

COLORATION AND LUMINESCENCE CAUSED BY BECQUE-REL RAYS AND RELATED PHENOMENA. V. Karl Przibram. *Z. Physik* **130**, No. 3, 269-92(1951). (In German)

The author has assembled, correlated, and evaluated published information on the following subjects: coloration of NaCl and KCl crystals by  $\alpha$ ,  $\beta$ ,  $\gamma$ , and cathode rays; color centers in NaCl; natural radiation-induced coloration in rock salt from various sources; triboluminescence in NaCl and KCl exposed to Ra radiation; photoelectric conductivity in naturally colored rock salt; coloration of Li, Na, K, and Rb borates; and fluorescence and coloration of natural fluorites and of  $\text{CaF}_2$  containing divalent rare earths ( $\text{Eu}^{++}$ ,  $\text{Sm}^{++}$ ,  $\text{Yb}^{++}$ ). 87 references.

143

DECOMPOSITION OF WATER BY ALPHA RADIATION. Marc Lefort. *J. chim. phys.* **48**, 339-43(1951) July-Aug. (In French)

Results of a study on the rates of formation of  $\text{H}_2\text{O}_2$ ,  $\text{O}_2$ , and  $\text{H}_2$  in pure  $\text{H}_2\text{O}$  continuously irradiated with radon  $\alpha$  rays from 0 to  $300 \times 10^{18}$   $\text{ev/cm}^2$  are tabulated and plotted. Reasons are given for considering the free-radical reactions  $\text{OH} + \text{OH} \rightarrow \text{H}_2\text{O}_2$  and  $\text{H} + \text{H} \rightarrow \text{H}_2$  as primary reactions are given. Included in this paper is a tabulation of the molecular extinction coefficients of  $\text{H}_2\text{O}_2$  in the range 2000 to 2600 Å, as measured by author.

144

ON THE PRIMARY REACTIONS PRODUCED BY IONIZING RADIATIONS IN WATER. Moïse Haïssinsky and Michel Magat. *Compt. rend.* **233**, 954-6(1951) Oct. 22. (In French)

The high production of  $\text{H}_2$  and the predominance of oxidation and hydroxylation reactions in water irradiated with protons;  $x$ ,  $\gamma$ , and  $\alpha$  rays; etc; may be explained by assuming that the reaction  $\text{H}_2\text{O} + e \rightarrow \text{H}_2 + \text{O}^-$  is at least as important as the  $\text{H}_2\text{O} + e \rightarrow \text{H} + \text{OH}^-$  reaction. The unstable  $\text{O}^-$  reacts with another solvent molecule:  $\text{H}_2\text{O} + \text{O}^- \rightarrow \text{OH} + \text{OH}^-$ . Many observed reductions may be explained as reactions of  $\text{H}_2\text{O}_2$ ,  $\text{OH}$ , or  $\text{OH}_2$  resulting from the latter reaction.

145

A MEASUREMENT OF THE FREE RADICALS PRODUCED IN ORGANIC LIQUIDS BY THE ACTION OF  $\gamma$  RAYS. Adolphe Chapiro. *Compt. rend.* **233**, 792-4(1951) Oct. 8. (In French)

The numbers of free radicals per ion pair produced by Ra  $\gamma$  radiation have been measured by reaction of the free radicals with 1,1-diphenyl-2-picrylhydrazyl for the following compounds:  $\text{CS}_2$ , acrylonitrile, benzene, styrene, toluene, xylene, ethylbenzene, nitrobenzene,  $n$ -heptane,  $n$ -octane, cyclohexane, ether, dioxane, methanol, propanol, methyl acrylate, methyl methacrylate, ethyl acetate, vinyl acetate, acetone, chlorobenzene,  $o$ -dichlorobenzene, ethyl bromide, 1,2-dichloroethane, chloroform, and  $\text{CCl}_4$ . The method is compared with a polymerization technique as to accuracy.

146

ROLE OF OXYGEN-CONTAINING RADICALS IN THE OXIDATIONS AND REDUCTIONS PRODUCED BY IONIZING RADIATION. II. REACTION MECHANISM FROM ANALYSIS OF THE GAS PRODUCED. M. Lefort and M. Haïssinsky. *J. chim. phys.* **48**, 368-71(1951) July-Aug. (In French)

Experimental determinations of the  $\text{O}_2$  and  $\text{H}_2$  produced by the reduction of 0.001M  $\text{Ce}(\text{SO}_4)_2$  in 0.8N aqueous  $\text{H}_2\text{SO}_4$  irradiated with 200,000 to 400,000 r (incident) of  $x$  rays or 45 to 74  $\mu\text{c}$  of radon  $\alpha$  rays and by the oxidation of 0.001M  $\text{Ce}(\text{III})$  in 3M  $\text{K}_2\text{CO}_3$  irradiated with 100,000 r of  $x$  radiation have confirmed and made more precise the reduction mechanism proposed in part I (Haïssinsky et al., *J. chim. phys.* **48**, 208(1951); NSA 5-5593). The reaction is not caused by H atoms, but by oxygenated derivatives of the decomposition of the solvent: OH in the case of  $x$  irradiation,  $\text{H}_2\text{O}_2$  and OH for  $\alpha$  irradiation. Some data on the oxidation of 0.001N  $\text{FeSO}_4$  in 0.8N  $\text{H}_2\text{SO}_4$  by 200,000 r of  $x$  radiation are included.

## RARE EARTHS AND RARE-EARTH COMPOUNDS

147

THE HEAT CONTENT, SPECIFIC HEAT, AND ENTROPY OF  $\text{La}_2\text{O}_3$ ,  $\text{Pr}_6\text{O}_{11}$  and  $\text{Nd}_2\text{O}_3$  BETWEEN 30 and 900°. J. O. Blomeke and W. T. Ziegler. *J. Am. Chem. Soc.* **73**, 5099-5102(1951) Nov.

The heat contents of  $\text{La}_2\text{O}_3$ ,  $\text{Pr}_6\text{O}_{11}$ , and  $\text{Nd}_2\text{O}_3$  have been measured from 30 to 900° using a copper aneroid calorimeter. Equations expressing the heat content, heat capacity, and entropy of each of the rare earth oxides have been derived from the observed heat contents. As a means of testing the operational characteristics of the calorimeter, the heat content of a standard sample of  $\alpha$ - $\text{Al}_2\text{O}_3$  was measured and found to compare favorably with values reported by other investigators. (auth)

## SEPARATION PROCEDURES

148

Oak Ridge National Lab.  
THE SEPARATION OF SUGARS BY ION EXCHANGE (abstract); by Joseph X. Khym and L. P. Zill. [nd] 1p. (AECU-1688)

The report is reproduced here in its entirety.

The long-known formation of anionic complexes by the reaction of polyhydroxy compounds with borate ion has made it possible to apply the principles of ion exchange to the separation of sugars. The separations are dependent upon the variations in affinity of the sugar-borate complexes for the exchanger resin. The general pattern of the procedure is similar to that used in the separation of the nucleotides by means of ion exchange. Quantitative separations of prepared mixtures of hexoses, pentoses, and disaccharides have been achieved up to the present time. On the basis of these observations, the use of the method for analysis, investigation, and production of sugars can be formulated. The reactions of sugars with borate ion and the details of the experimental separations will be presented. (Paper presented at American Society of Plant Physiologists, Sept. 1951, Minneapolis)

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Oak Ridge National Lab.  
AUTORADIOGRAPHIC MEASUREMENTS OF DESOXY-PENTOSE NUCLEIC ACID (DNA) SYNTHESIS DURING THE MITOTIC AND MEIOTIC CYCLES (abstract); by J. Herbert Taylor. [nd] 1p. (AECU-1693)

The report is reproduced here in its entirety.

Inflorescences of *Lilium longiflorum* and *Tradescantia paludosa* were placed in solutions of phosphate with  $\text{P}^{32}$  at activities from 20 to 75  $\mu\text{c}/\text{ml}$ . At intervals of 8 to 28 hr after the  $\text{P}^{32}$  reached the buds, cells from anthers were smeared on microscope slides, fixed in alcohol-acetic acid, hydrolyzed in 1N HCl for 10 min at 60°C, stained with the Feulgen reagent, and, after washing in distilled water, coated with a stripping emulsion layer 5  $\mu$  thick, which may be



stripped from "Kodak" autoradiographic plates especially designed for the purpose. After 14 days exposure the film was developed, fixed, and mounted in balsam for microscopic examination. The cells may be seen, and grains appear in the emulsion above those in which radioactivity is present. The treatments remove all phosphorus except that in the nucleus, which is assumed to be DNA phosphorus. The presence of activity is usually either quite marked or absent. Little difference is shown between 8 and 24 hr of contact with  $P^{32}$ . This indicates that the incorporation of phosphorus in DNA occurs quickly and is limited to definite stages of the cell cycle. This period is assumed to correspond to DNA synthesis and hence to chromosome reproduction. It does not occur in any stage in which the chromosomes are tightly coiled. There is no synthesis in any stage of meiosis or mitosis with the possible exception of early leptotene of meiosis. Synthesis occurs in the resting stage when the chromosomal fiber has part of the spirals absent and the remainder very loose. In this extended state the long nucleoprotein fiber may act as a template for its own reproduction. (Paper presented at Botanical Society of America, Sept. 1951, Minneapolis)

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Oak Ridge National Lab.

THE ENZYMATIC HYDROLYSIS OF GLYCONYL PEPTIDE DERIVATIVES (abstract); by David G. Doherty. [nd] 1p. (AECU-1698)

The report is reproduced here in its entirety.

In view of the interesting solubility properties of the glyconyl peptide derivatives, several of them were subjected to enzymatic action. Papain hydrolyzed both D-arabonyl glycine amide and D-gluconyl glycine amide slowly to the free acid and ammonia. D-Arabonyl-L-tyrosine amide was readily hydrolyzed by  $\alpha$  chymotrypsin. The Km for this combination was 0.05M. D-Gluconyl-L-tyrosine amide was split much more slowly than the corresponding arabonyl compound, possibly due to the different configuration around the  $\alpha$  carbon of the aldonic acid. A crude kidney homogenate readily hydrolyzed penta-acetyl-D-gluconyl glycine. (Paper presented at the Meeting of Twelfth International Congress of Pure and Applied Chemistry, New York, N. Y., Sept. 10-13, 1951)

151

Atomic Energy Research Establishment, Harwell, Berks (England)

THE PRODUCTION OF IODINE 131 FROM PILE IRRADIATED TELLURIUM AT ABOUT THE CURIE LEVEL OF ACTIVITY; by W. J. Arrol. Sept. 11, 1951. 2p. (AERE-I/R-777)

Te which has been irradiated in the pile and contains 300 to 400 mc of iodine is dissolved in chromium trioxide and  $H_2SO_4$ . The iodic acid in this solution is reduced with oxalic acid to the elementary state. The iodine is distilled out and trapped in alkaline bisulfite. Oxalic acid in the distillate is destroyed by  $KMnO_4$  and the iodine is restored to the elementary state with  $H_2SO_4$ . The  $I^{131}$  is redistilled into 0.01N NaOH into which  $SO_2$  has been passed. The pH is adjusted to 8 to 9 and the solution is evaporated down to about 10 mc/ml. A yield of about 90% has been obtained.

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Radiation Lab., Univ. of Calif.

CARRIER-FREE RADIOISOTOPES FROM CYCLOTRON TARGETS; XXVI. PREPARATION AND ISOLATION OF  $W^{181}$  FROM TANTALUM; by Jeanne D. Gile, Warren M. Garrison, and Joseph G. Hamilton. Sept. 19, 1951. 3p. (UCRL-1429)

The report is reproduced here in its entirety.

Deuteron bombardment of Ta produces the 140-day  $W^{181}$  by the nuclear reaction  $Ta^{181}(d,2n)W^{181}$  (Seaborg and Perl-

man, *Revs. Modern Phys.* 20, 585 (1948)). This paper reports a radiochemical isolation of carrier-free  $W^{181}$  from a Ta target bombarded with 19-Mev deuterons in the 60-in. cyclotron at Crocker Laboratory. Other possible concurrent reactions include formation of radioisotopes of Ta by the (d,p) reaction and Hf by the (n,p) reaction. The target, a circular plate of Ta metal (spectrographic analysis of Ta foil showed it to be tungsten-free) ~10 mil thick, mounted in a bell-jar type of target assembly, was bombarded with 19-Mev deuterons for a total of 500  $\mu$ a-hr at an average beam intensity of 20  $\mu$ a. The back of the Ta foil was cooled with a stream of cold water. After bombardment, the Ta foil was trimmed and the inactive metal discarded. The Ta was dissolved in a minimum volume of 16N  $HNO_3$  containing 10% HF by volume in a Pt evaporating dish. The HF was removed by boiling with 36N  $H_2SO_4$  and the cooled acid solution poured slowly into an excess of 20% NaOH with constant stirring. The precipitate was digested for 30 min and the Ta hydroxide separated by centrifugation with repeated reductions in volume of the basic solution. The carrier-free W was retained in the supernatant. This process was repeated three times to ensure complete removal of the radiotungsten from the Ta target. The combined supernatants were evaporated to a small volume, the  $Na_2SO_4$  formed by evaporation was centrifuged out, and the radiotungsten was recovered in the supernatant. The basic solution was acidified with HCl, 5 mg of  $Fe^{+3}$  were added, and the solution was carefully brought to pH 4 with NaOH. At this pH the  $Fe(OH)_3$  carries the radiotungsten quantitatively. Three such precipitations were done to ensure the complete removal of any Ta present. The  $Fe(OH)_3$  was dissolved in 6N HCl and the Fe extracted with ethyl ether. The aqueous phase containing HCl and  $W^{181}$  was evaporated to dryness on 20 mg NaCl. The activity dissolved quantitatively in distilled water. The decay curve was followed for 130 days and showed the 140-day half life of  $W^{181}$ . Mass absorption measurements in Al and Pb showed the 0.07-Mev conversion electron and the 0.13- and 1.8-Mev  $\gamma$  rays previously reported for  $W^{181}$  (Wilkinson, *Nature* 160, 864 (1947)). A trace amount of carrier-free W was added to a solution containing milligram amounts of W, Ta, and Hf; the W fraction was separated chemically and contained 98% of the activity.

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Radiation Lab., Univ. of Calif.

CARRIER-FREE RADIOISOTOPES FROM CYCLOTRON TARGETS; XXV. PREPARATION AND ISOLATION OF  $Au^{195,196,198,199}$  FROM PLATINUM; by Jeanne D. Gile, Warren M. Garrison, and Joseph G. Hamilton. Sept. 19, 1951. 3p. (UCRL-1483)

The report is reproduced here in its entirety.

Radioactive gold, produced by bombardment of platinum with 19-Mev deuterons, has been isolated without added isotopic carrier. Four known long-lived radioisotopes of gold (Seaborg and Perlman, *Revs. Modern Phys.* 20, 585 (1948)) are produced by (d,n) and (d,2n) reactions with deuterons of this energy: 180-day  $Au^{195}$ , 5.6-day  $Au^{196}$ , 2.7-day  $Au^{198}$ , and 3.3-day  $Au^{199}$ . The shorter-lived activities ( $Au^{193}$  and  $Au^{194}$ ) were allowed to decay out prior to chemical separation. Other possible concurrent reactions include formation of radioisotopes of Pt by (d,p) reactions and radioisotopes of Ir by (n,p) reactions. The carrier-free radiogold was separated from the target material and from possible radioisotopes of Ir by a solvent extraction method using ethyl ether.

Five 1-mil foils of c.p. platinum (spect. pure platinum, less than 0.01% gold) were clamped to a water-cooled Cu target plate and bombarded with 19-Mev deuterons for a total of 20  $\mu$ a-hr at an average beam intensity of 10  $\mu$ a, in

the 60-in. cyclotron at Crocker Laboratory. The bombarded foils were dissolved in a minimum volume of aqua regia. To destroy excess  $\text{HNO}_3$ , 12N  $\text{HCl}$  was added, the solution was diluted to ~15 ml of 3N  $\text{HCl}$ , and the radiogold was extracted with ethyl ether which had previously been saturated with 3N  $\text{HCl}$ . Four extractions with ethyl ether were needed to remove most of the radio-gold from the aqueous phase. The ether layer was washed with 6N  $\text{HCl}$  and the activity was quantitatively retained in the organic layer. Fifty mg of  $\text{NaCl}$  was added to the ether phase, and the mixture was evaporated to 1 ml on a steam bath. The carrier-free radiogold plus the  $\text{NaCl}$  was diluted to 5 ml to give an isotonic saline solution for subsequent biological investigations. The radiogold was identified by half-life determinations, absorption measurements, and a chemical separation procedure using carriers. The decay was followed for 60 days and showed an initial composite half period of ~3.5 days, presumably due to  $\text{Au}^{198,199}$ . Four days after chemical separation the decay curve showed mainly the 5.6-day period of  $\text{Au}^{196}$  (Nat'l. Bur. Standards (U.S.), Circ. 499, Sept. 1950). After 15 days the curve began to lengthen perceptibly, and 25 days after chemical separation the activity showed only the 180-day period, which was presumably  $\text{Au}^{196}$ . Aluminum- and lead-absorption measurements 6 days after bombardment showed the ~0.43-Mev  $\beta$  particle and the 0.37-Mev  $\gamma$  ray previously reported (Wilkinson, Phys. Rev. 75, 1019(1949)) for  $\text{Au}^{196}$ . An aliquot of the solution was added to a solution containing carrier amounts of Ir, Pt, and Au. The radioactivity was quantitatively recovered in the Au fraction following chemical separation.

#### SORPTION PHENOMENA

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THE HEAT CAPACITY, INTEGRAL HEAT OF ADSORPTION AND ENTROPY OF ARGON ADSORBED ON TITANIUM DIOXIDE. J. A. Morrison, J. M. Los, and L. E. Drain. Trans. Faraday Soc. 47, 1023-30(1951) Sept.

Direct measurements of the heat capacity of argon adsorbed at three low concentrations on titanium dioxide have been made in the temperature range 14 to 105° K. At higher temperatures, up to 130° K, the heat capacity of the adsorbed argon has been determined from the temperature coefficient of the integral heat of adsorption. Between 14 and 25° K the heat capacity appears to be that of a three-dimensional oscillator in agreement with the idea of localization at these temperatures. At the higher temperatures the heat capacity rises to values much larger than can be accounted for on the basis of any simple model of the adsorbed phase. The zero-point entropy of the adsorbed argon has been calculated at three concentrations and found to be zero within experimental error. A reasonable interpretation of this result is that the solid surface is heterogeneous energetically. (auth)

#### SPECTROSCOPY

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Atomic Energy Research Establishment, Harwell, Berks (England)  
CHARACTERIZATION OF IMPURITIES IN BORON TRIFLUORIDE BY INFRA-RED ABSORPTION SPECTRA; by J. Gaunt. Oct. 11, 1951. 5p. (AERE-C/M-124)

The infrared absorption spectra of two samples of  $\text{BF}_3$  have been examined. The spectrum of the first sample, which was unsuitable for counters, exhibits two bands which are not characteristic of  $\text{BF}_3$ , one at 1363  $\text{cm}^{-1}$  and one at 1030  $\text{cm}^{-1}$ . The first has been assigned to  $\text{SO}_2$  and the second to  $\text{SiF}_4$ , due to the attack of  $\text{BF}_3$  on the glass absorption cell. The second sample, which was found to be suitable counting

material, shows these same bands and a third at 950  $\text{cm}^{-1}$  which is typical of the  $\nu_7$  fundamental of ethylene. Even with the moderate dispersion afforded by the rock salt prism, the isotopic doubling of the  $\nu_2$  fundamental of  $\text{BF}_3$  at 691 and 719  $\text{cm}^{-1}$  is readily observed.

156

Atomic Energy Research Establishment, Harwell, Berks (England)

SOME PRELIMINARY OBSERVATIONS ON THE RAMAN SPECTRA OF URANYL SALTS; by J. Sutton. Aug. 31, 1951. 13p. (AERE-C/R-769)

Raman spectra of the following solutions were obtained: saturated uranyl chloride, saturated uranyl chloride saturated with  $\text{HCl}$  gas, saturated uranyl chloride saturated with  $\text{CaCl}_2$ , saturated uranyl chloride saturated with  $\text{UO}_3$ , and saturated uranyl nitrate. Microphotometer tracings of the data are shown graphically. The allowed symmetric vibration of the linear model is shown at 865  $\text{cm}^{-1}$  and also the broadening of the incident line due to the appearance of the forbidden vibration. The asymmetric frequency 980  $\text{cm}^{-1}$  is especially prominent in the  $\text{UO}_3$ -saturated uranyl chloride. Diffuse bands observed in the regions around 1600 and 3500  $\text{cm}^{-1}$  were due to water. A discussion is given of the possible structure of the uranyl ions.

157

Ames Lab.

ZINC - 1,10-PHENANTHROLINE COMPLEXES AND THEIR ANALYTICAL APPLICATION; by John Hibbert McClure and C. V. Banks. June 1951. 65p. (ISC-164)

The method of continuous variations, developed by Job, the mole ratio method, and a conductometric method indicated that the most probable ratio of 1,10-phenanthroline to zinc in their complex is 2:1. However, it was shown that more than one complex is formed and it was finally concluded that there were three complexes. The dissociation constants for the three complexes were evaluated by a method of successive approximations. The values of these constants were estimated to be  $3.4 \pm 0.3 \times 10^{-7}$  for  $K_1$ ,  $1 \times 10^{-12}$  for  $K_2$ , and  $9.17 \pm 2.12 \times 10^{-14}$  for  $K_3$ . The molar absorptivity indexes for the three complexes were evaluated and estimated to be 10,000, 18,500, and 28,500, respectively, for the 1:1, 2:1, and 3:1 complexes. A standard curve was prepared and the data treated statistically to determine the best straight line through the data. The data were further analyzed to determine the confidence limits. A study of interferences was conducted and attempts were made to eliminate as many of them as possible. Due to the extreme sensitivity of iron(II) to 1,10-phenanthroline the method has limited use since iron occurs as a contaminant in so many materials. Sodium p-sulfobenzeneearsonic acid was prepared and investigated as a possible complexing agent for zirconium. This material prevents the precipitation of zirconium(IV) in the pH range being used but itself has a high absorption in the wavelength range where the work was done and consequently it is unsuitable for use in the method. (auth)

158

Atomic Energy Project, Univ. of Calif., Los Angeles  
EMISSION SPECTROGRAPHIC ANALYSIS OF ORGANIC SOLIDS FOR INORGANIC CONSTITUENTS; by Ralph E. Nusbaum and Geo. V. Alexander. Issued Nov. 2, 1951. 13p. (UCLA-163)

An emission spectrographic method for the determination of Na, K, Ca, Mg, Ba, Fe, and P in organic solids without previous ashing is described. The range of analysis is from 0.02 to 6% for Na, K, Ca, Mg, Ba, and Fe and from 2 to 18% for P. A weighed portion of the sample is mixed 1:4 with a  $\text{Li}_2\text{CO}_3$ - $\text{V}_2\text{O}_5$  buffer-internal standard. This mixture is then placed in a graphite platform electrode



and burned to completion in an 8 amp d-c arc. Repeat observations on a single sample show a standard deviation between 2.5 and 6.1% for Na, K, Ca, Mg, Ba, and Fe and 9.9% for P. (auth)

159

Iowa State Coll.

THE RED ABSORPTION MAXIMUM OF CHLOROPHYLL AT HIGH CONCENTRATIONS; by S. Aronoff. Sept. 26, 1951.

6p. (AECU-1676)

The absorption spectrum of chlorophyll solutions was investigated. Very little shift in absorption maximum of crude chlorophyll solutions at high concentrations over the range of 0.0001M to 1.0M (undiluted) was found. The absorption maximum in the living leaf was found to exceed that of the undiluted chlorophyll. It was concluded that, in the leaf, chlorophyll is associated with some other substance.

160

THE CARBON EFFECT IN THE SPECTROGRAPHIC ANALYSIS OF REFRACTORY MATERIALS. Raymond Ricard. *Compt. rend.* 233, 953-4(1951) Oct. 22. (In French)

The intensity of the spectrographic lines of a particular metal in a refractory will vary greatly depending on the volatility of its oxide. Admixture of graphite powder normalizes the excitation and reduces the influence of the composition of the refractory.

161

PREDICTION OF ATOMIC SPECTRAL LINES IN THE INFRARED. J. W. Swenson. *Mém. soc. roy. sci. Liège* (4) 11, No. 1, 1-123(1951). (In French)

Calculated wavelengths in air, wave numbers in vacuum, corresponding multiplet transitions, and theoretical relative intensities are tabulated for H, C(I), Na(I), Mg(I), Al(I), Si(I), K(I), Ca(I), Ti(I), and Fe(I) in the infrared.

## SYNTHESES

162

Oak Ridge National Lab.

THE SYNTHESIS OF GLYCONYL PEPTIDES (abstract); by David G. Doherty. [nd] 1p. (AECU-1684)

The report is reproduced here in its entirety.

A new class of carbohydrate amino acids which might be of biochemical interest has been synthesized. They are aldonic acids coupled through their carboxyl group in a stable CO-NH<sub>2</sub> linkage to the amino group of amino acids. The name glyconyl peptide is proposed for this type of compound as its major difference from a peptide is the replacement of the NH<sub>2</sub> group in  $\alpha$  position to the peptide linkage by a hydroxyl group. These compounds are prepared by coupling the acetylated aldonyl chloride with a free amino acid ethyl ester to give an excellent yield of acetylated aldonyl amino acid ester. This compound can be catalytically deacetylated to yield the aldonyl amino acid ester and either de-esterified to the free aldonyl amino acid or converted to the amide with methanolic ammonia. This series of reactions has been carried out with the following aldonyl chlorides and amino acids and esters: penta-acetyl-D-gluconyl chloride, tetra-acetyl-D-arabonyl chloride, tetra-acetyl-D-ribonyl chloride; glycine, L-leucine, L-phenylalanine, L-tyrosine, L-glutamic acid, and glycyl glycine. The glyconyl peptide esters and amides crystallized readily and were appreciably more water soluble than the corresponding acetyl and benzoyl derivatives, providing soluble substrates for the investigation of enzymatic reactions. (Paper presented at the Meeting of Twelfth International Congress of Pure and Applied Chemistry, New York, New York, September 10-13, 1951.) Published in Abstracts of Papers Presented at the Meeting of the Twelfth International Congress of Pure and Applied Chemistry, p. 98, 1951.

163

Argonne National Lab.

BIOSYNTHESIS OF C<sup>14</sup> LABELED FORM OF DEXTRAN; A BLOOD PLASMA VOLUME EXPANDER; by Norbert J. Scully, Homer E. Stavely, John Skok, Alfred R. Stanley, J. K. Dale, J. T. Craig, E. B. Hodge, William Chorney, Ronald Watanabe, and Robert Baldwin. Oct. 1951. 8p. (AECU-1702; UAC-452)

The method of biosynthesis of C<sup>14</sup>-labeled dextran is described. The process involves the biosynthesis of labeled C<sup>14</sup> sucrose, produced by allowing carbohydrate-depleted excised canna leaves to photosynthesize in the presence of C<sup>14</sup>O<sub>2</sub>, followed by the biosynthesis of labeled dextran through fermentation of this sugar. The bacterium *Leuconostoc mesenteroides* was employed in these fermentations. Depolymerization of the native dextran was accomplished by acid hydrolysis, followed by treatment with methanol to separate the dextran by fractionation from the aqueous solution. The final sterile and pyrogen-free product was made up to a 6% dextran solution with 0.9% NaCl. Specifications for the final product are presented in tabular form.

164

Argonne National Lab.

SYNTHESIS OF 3-INDOLEACETIC ACID-2-C<sup>14</sup>; by R. E. Stutz, D. E. Atkinson, and S.A. Gordon. Oct. 1951. 12p. (ANL-4710)

C<sup>14</sup>-labeled 3-indoleacetic acid was prepared through the sequence carbon dioxide → formaldehyde → gramine indoleacetonitrile → 3-indoleacetic acid. The label was introduced into the methylene position of the acetic acid side chain. Details of the synthesis are discussed.

165

Brookhaven National Lab.

THE HETEROLACTIC FERMENTATION; II. POSITION OF C<sup>14</sup> IN THE PRODUCTS OF GLUCOSE DISSIMILATION BY *LEUCONOSTOC MESENTEROIDES*; by I. C. Gunsalus and Martin Gibbs. [nd] 13p. (BNL-1013)

Experiments on the fermentation of glucose-1-C<sup>14</sup> and glucose-3, 4-C<sup>14</sup> by the heterofermentative lactate acid coccus, *Leuconostoc mesenteroides*, indicate that the mechanism whereby glucose is converted to lactate, ethanol, and CO<sub>2</sub> by this heterolactic organism involves a new pathway and although the Embden-Meyerhof scheme may function in part, a considerable digression from this scheme occurs.

166

Metalloy Corp.

ANNOTATED BIBLIOGRAPHY ON THE USE OF ORGANO-LITHIUM COMPOUNDS IN ORGANIC SYNTHESIS. Jan. 1, 1949. 79p. (NP-3473)

167

Radiation Lab., Univ. of Calif.

THE PATH OF CARBON IN PHOTOSYNTHESIS; XIV; by Melvin Calvin, J. A. Bassham, A. A. Benson, S. Kawaguchi, V. H. Lynch, W. Stepka, and N. E. Tolbert. June 30, 1951. 51p. (UCRL-1386)

Results are reported of an investigation of the path of carbon from CO<sub>2</sub> to reduced materials during photosynthesis. Plants were exposed to C<sup>14</sup>O<sub>2</sub> under controlled conditions. Photosynthetic products were identified through a combination of paper chromatography and radioautography. Incorporation of C<sup>14</sup> into glyceric acid, glycolic acid, and sucrose was measured. Results are presented in tabular form. A number of intermediate photosynthetic products were identified.

168

Radiation Lab., Univ. of Calif.

MEASUREMENT OF PHOSPHORUS-CARBON RATIOS IN SOME PHOTOSYNTHESIS INTERMEDIATES; by A. A. Benson. Aug. 1951. 7p. (UCRL-1412)

The ratios of carbon to phosphorus in several phosphorylated intermediates of photosynthetic carbon dioxide fixation have been determined by measuring carbon and phosphorus radioactivity when they are saturated with  $C^{14}$  and  $P^{32}$ . The data obtained in these preliminary experiments with *Scenedesmus* serve as evidence for the identifications for sedoheptulose monophosphate and ribulose diphosphate and provide information regarding the degree of saturation with  $C^{14}$  for a number of phosphorylated compounds. The concentration of these compounds has been measured.

The methods used are particularly applicable for phosphate esters isolable by paper chromatography. (auth)

169

THE ISOTOPE DISTRIBUTION IN THE RAPIDLY METABOLIZING FATTY ACID FRACTION OF THE LIVER.

G. A. Swan. *Arkiv Kemi* **3**, 167-9(1951).

The liver fatty acids of mice, isolated short times (15 to 100 min) after the intraperitoneal injection of  $1-C^{14}$  acetate, were subjected to the Schmidt reaction. The isotope concentration of the evolved carbon dioxide, the original acids, and the amines formed were compared. The results suggest that the  $C^{14}$  is uniformly distributed at alternate carbon atoms throughout the whole fatty acid molecule, except in the acids isolated from the shortest term experiments; in these latter acids there appears to be some excess of  $C^{14}$  in the carboxyl group. (auth)

170

THE SYNTHESIS OF 17  $\alpha$ -ETHYNYLTESTOSTERONE-20, 21- $C^{14}$ . Byron Riegel and Yu Cheng Liu. *J. Org. Chem.* **16**, 1610-14(1951) Oct.

A method has been developed for the preparation of 17  $\alpha$ -ethynyltestosterone-20-21- $C^{14}$  which involves the condensation of 3-ethoxy-3,5-androstadien-17-one with potassium radioacetylide followed by hydrolysis of the 3-enol ether. An easily constructed reaction flask was designed for the preparation. (auth)

171

TRACER STUDIES ON THE METABOLISM OF THE GARDNER LYMPHOSARCOMA. IV. THE CONVERSION OF LACTATE-2- $C^{14}$  TO ALANINE, GLUTAMATE, AND ASPARTATE BY TUMOR AND SPLEEN CELLS. Saul Kit and David M. Greenberg. *Cancer Research* **11**, 791-4(1951) Oct.

When mouse lymphosarcoma or spleen cells were incubated with lactate-2- $C^{14}$ , significant radioactivity was found in the respiratory  $CO_2$ . The only amino acids strongly labeled were alanine, glutamate, and aspartate; and the protein was also significantly labeled. Negligible radioactivity was found in the fats. In the spleen cells, the glutamate and aspartate contained almost equal radioactivity, while the alanine was less radioactive. On the other hand, in the lymphosarcoma cells the alanine had twice as much radioactivity and the aspartate one-fifth as much as the glutamate. (auth)

172

PREPARATION OF 1- $C^{14}$ -D-XYLOSE FROM 1- $C^{14}$ -D-GLUCOSE. John C. Sowden. *J. Am. Chem. Soc.* **73**, 5496-7(1951) Nov. (Notes)

1- $C^{14}$ -D-glucose was acetonated and the resulting diacetoneglucose was hydrolyzed to monoacetoneglucose. The latter was oxidized with aqueous sodium metaperiodate and the resulting 5-aldo-monoacetoneglycose was re-

duced to monoacetoneglycose which hydrolyzed to 1- $C^{14}$ -D-xylose. This procedure did not involve isolation of the intermediates, and a yield of 55 to 60% was obtained.

173

BIOSYNTHESIS OF RADIOACTIVE TESTOSTERONE IN VITRO. Roscoe O. Brady. *J. Biol. Chem.* **193**, 145-8(1951) Nov.

Surviving testicular tissue slices from hog, rabbit, and human testes can convert labeled acetate to testosterone. Human chorionic gonadotropin markedly accelerates this process in rabbit testicular tissue, but is without effect on the incorporation of acetate into cholesterol. Evidence is cited which suggests that cholesterol may not be an important intermediate in the biosynthesis of testosterone. (auth)

174

THE SYNTHESIS OF RADIOACTIVE CHOLESTEROL AND FATTY ACIDS IN VITRO. Roscoe O. Brady, J. Rabinowitz, J. Van Baalen, and Samuel Gurin. *J. Biol. Chem.* **193**, 137-43(1951) Nov.

$C^{14}$ -labeled vinylacetic acid, crotonaldehyde, aldol, acetoin, and orsellinic acid have been prepared and their conversion to cholesterol and fatty acids by liver slices studied. None of these substances appears to be an important precursor, with the exception of aldol which is probably converted partly into acetoacetate and to some extent into 2-carbon fragments. Labeled formate and formaldehyde are not significantly converted by liver slices to cholesterol or fatty acids. Human adrenal slices, as well as rabbit testis, are capable of synthesizing acetoacetate from labeled acetate. A new synthesis of  $C^{14}$ -labeled acetoin is described. (auth)

175

STUDIES IN THE WAGNER REARRANGEMENT. II. THE SYNTHESIS AND STRUCTURE DETERMINATION OF BENZ[a]ANTHRACENE-5,6- $C^{14}$ . Clair J. Collins, John G. Burr, Jr., and Daniel N. Hess. *J. Am. Chem. Soc.* **73**, 5176-8(1951) Nov.

The synthesis of benz[a]anthracene-5,6- $C^{14}$  is reported in an over-all yield, from  $C^{14}O_2$ , of 76%. Degradation of this labeled hydrocarbon indicates that the radioactivity is distributed between positions 5 and 6 of the benz[a]anthracene structure in the ratio 48:52.

TRACER APPLICATIONS

176

THE RADIOACTIVE MEASUREMENT OF THE ADSORPTION OF DISSOLVED SUBSTANCES ON LIQUID SURFACES AND AN APPLICATION TO "IMPURITIES" IN DODECYL SODIUM SULFATE SOLUTIONS. G. Aniansson. *J. Phys. & Colloid Chem.* **55**, 1286-99(1951) Nov.

The use of soft  $\beta$  emitters,  $\alpha$  emitters, and isotopes with radioactive recoil atoms for the measurement of the adsorption of dissolved substances at liquid surfaces is discussed. A method is described for measurements with  $S^{35}$ ,  $C^{14}$ , and  $Ca^{45}$ . Results of measurements of the surface adsorption of hexadecyl sodium sulfate and calcium ions as "impurities" in dodecyl sodium sulfate are given and discussed.

177

AN APPLICATION OF HEAVY OXYGEN TO THE STUDY OF OXIDATION CATALYSIS. G. Ya. Turovskii and F. M. Vainshtein. *Doklady Akad. Nauk S.S.S.R.* **78**, No. 6, 1173-5(1951) June 21. (In Russian)

The mechanism of catalytic oxidation of CO, previously studied over  $MnO_2^{18}$  (Vainshtein and Turovskii, *Doklady Akad. Nauk S.S.S.R.* **72**, 297(1950); NSA 4-6357) has now been investigated over  $CuO^{18}$ .



178

**WOLFF-KISHNER REDUCTION OF PYRUVIC AND 3-FORMYLPROPIONIC ACIDS.** E. H. Mosbach, E. F. Phares, and S. F. Carson. *J. Am. Chem. Soc.* **73**, 5477-8(1951) Nov. (Notes)

Pyruvic-2-C<sup>14</sup> acid and 3-(formyl-C<sup>14</sup>)-propionic acid were reduced by the Wolff-Kishner method to propionic-2-C<sup>14</sup> acid and butyric-4-C<sup>14</sup> acid, respectively. Step-by-step degradation of the products showed no detectable rearrangement of the carbon skeletons during reduction.

179

**THE REACTION OF FORMALDEHYDE WITH ALDEHYDES CONTAINING ONE  $\alpha$ -HYDROGEN ATOM.** John G. Burr, Jr. *J. Am. Chem. Soc.* **73**, 5170-2(1951) Nov.

The reaction of formaldehyde in basic solution with diphenyl-acetaldehyde has been found to give  $\beta,\beta$ -diphenyltrimethylene glycol. The reaction of this same reagent with  $\beta$ -hydroxy- $\alpha$ -phenyl-(acrylo- $\beta$ -C<sup>14</sup>)-phenone (tormyldesoxybenzoin), has been found to give a derivative of  $\alpha$ -hydroxymethyl-desoxybenzoin with displacement of the formyl group as formic-C<sup>14</sup> acid. There is also found 5 to 10% of the same derivative labeled with C<sup>14</sup>, presumably derived from direct reduction of the labeled diketone. These observations seem to be better correlated by the Cannizzaro reaction mechanism which involves intramolecular hydride ion transfer, than by the Cannizzaro reaction mechanism which demands an intermolecular hydride ion transfer.

## ENGINEERING

181

Atomic Energy Research Establishment, Harwell, Berks (England)

**A LABORATORY RESISTANCE WELDING UNIT;** by R. D. Semmens. Aug. 22, 1951. 10p. (AERE-M/R-739)

A laboratory model for the resistance welding of a large variety of metals is described, and has been tried successfully with such combinations of metals as tungsten, tantalum, molybdenum, zirconium, etc. The machine is based on discharge of a capacitor through a welding transformer of low inductance and high coupling factor, the discharge being triggered through an air gap. (auth)

182

Naval Engineering Experiment Station, Annapolis  
**REPORT OF AN INVESTIGATION ON WATER AND STEAM LUBRICATED BEARINGS;** by William J. Vitelozzi. June 9, 1950. 24p. (EES-C-3229-C)

183

Chemical Corps  
**HYDRAULIC JETS AT LOW REYNOLDS NUMBER AND CONSTANT WEBER NUMBER** (Medical Laboratories Research Report No. 64); by G. M. Asset and P. D. Bales. June 1951. 21p. (NP-3466)

### HEAT TRANSFER AND FLUID FLOW

184

Hydrodynamics Labs., California Inst. of Tech.  
**DYNAMICS OF PARTICULATE MATTER IN FLUID SUSPENSIONS** (Final Report); by Vito A. Vanoni, En-Yun Hsu, and R. W. Davies. Nov. 1950. 29p. (NP-3478; U-17317)

An analytical and experimental study of the dynamics of particulate matter suspended in turbulent flow is reported.

### URANIUM AND URANIUM COMPOUNDS

180

Oak Ridge National Lab.

**STUDIES IN THE CARBONATE-URANIUM SYSTEM; PART I. INVESTIGATIONS IN THE FOUR COMPONENT SYSTEM  $UO_3$ - $Na_2O$ - $CO_2$ - $H_2O$ ;** by C. A. Blake, R. S. Lowrie, D. G. Hill, and K. B. Brown. Dec. 14, 1950. Decl. Nov. 26, 1951. 39p. (AECD-3280; Y-673)

Numerous solubility studies in the  $UO_3$ - $Na_2O$ - $CO_2$ - $H_2O$  system have been made. This system is characterized by a narrow region of solubility and a deep solubility well. Solutions containing greater than 320 g of U/liter have been obtained. A crosscut of the important solubility regions is given by the  $Na_2CO_3$ - $UO_2CO_3$ - $H_2O$  plane. This system is characterized by a sharp eutectic between two solubility fields. One of these fields represents solution in contact with tricarbonat solid ( $Na_4UO_2(CO_3)_3$ ), while the other is in contact with uranyl carbonate. Solutions existing along the curve defining the latter field appear to have a composition corresponding to the empirical formula  $Na_2UO_2(CO_3)_2$ . The eutectic occurs at about 29%  $UO_2CO_3$ , 10%  $Na_2CO_3$ , and 61%  $H_2O$ . Addition of  $Na_2O$  results in a marked decrease in solubility of the U except in the immediate vicinity of the plane of the  $Na_2CO_3$ - $UO_2CO_3$  system. The loss of  $CO_2$  from solutions near the eutectic mixture of the  $UO_2CO_3$ - $Na_2CO_3$ - $H_2O$  plane allows greater dissolution of U to take place. The  $Na_4UO_2(CO_3)_3$ - $NaHCO_3$ - $H_2O$  system shows solubilities very similar to those in the  $Na_4UO_2(CO_3)_3$ - $Na_2CO_3$ - $H_2O$  system. The solubility of  $UO_2CO_3$  in  $H_2O$  and NaOH is negligible.

The analytical study consists in the application of generalized diffusion theories to the problem, and the determination of relations between turbulence and diffusion of sediment particles with a view to calculating the diffusion coefficient of the particles. The experimental study consists in preliminary measurements and studies of diffusion in turbulent flows, and flume studies of sediment transportation. The apparatus described is a water tunnel which was designed to give a low turbulence level in the working section. With this tunnel, the intensity and scale of turbulence was controlled and the effect of these factors on the transport and diffusion of particles studied. A theoretical consideration of (a) sediment diffusion in turbulent flows and (b) turbulence in a rectangular box is given.

185

Oak Ridge National Lab.  
**EROSION DUE TO PARTICLE IMPINGEMENT UPON BENDS IN CIRCULAR CONDUITS;** by R. V. Bailey. Issued Nov. 21, 1951. 17p. (ORNL-1071)

A qualitative analysis, based on a number of assumptions, has been made of the erosion caused by small solid particles impinging upon a bend in a circular conduit. The resulting equation is

$$E = \text{Const.} \frac{U_{av}^{3.8} r (\rho_s - \rho_e)}{\mu R \rho_s^{0.6}} \left[ 1 + \frac{U_{av}^2 (\rho_s - \rho_e)^{2.8} r^{5.6}}{68 \mu^{2.8} R^{2.8}} \right]$$

where E is the weight loss of conduit per pound of particles,  $U_{av}$  is fluid velocity, r and R are radius of particle and of bend,  $\rho_s$  and  $\rho_e$  are density of solid and liquid, and  $\mu$  is viscosity.

186

Tennessee Univ.

EFFECT OF WETTING ON HEAT TRANSFER CHARACTERISTICS OF LIQUID METALS; SECOND QUARTERLY REPORT; by W. K. Stromquist. Oct. 31, 1951. 5p. (ORO-52)

Brief statements are made concerning progress made in construction of equipment to test the effects of wetting on heat-transfer characteristics of liquid metals.

187

A METHOD OF MEASURING THE COMPRESSIBILITY OF GASES AT HIGH PRESSURES. I. R. Krichevskii and D. S. Tsiklis. *Doklady Akad. Nauk S.S.S.R.* 78, No. 6, 1169-72(1951) June 21. (In Russian)

An apparatus is illustrated and described for measuring compressibilities to 10,000 atm. Mole volumes of  $N_2$  measured at 3097 to 6292 atm are compared with literature values.

188

ON THE PROBLEM OF MOTION OF SOLID PARTICLES IN A GAS STREAM. G. N. Khudyakov and Z. F. Chukhanov. *Doklady Akad. Nauk S.S.S.R.* 78, No. 4, 681-4(1951) June 1. (In Russian)

Results of experiments relating the velocity of particles in a gas stream to the velocity of the stream, the dimensions of the particles, Reynolds number, and the coefficient of resistance are presented graphically.

189

EFFECT OF DUST ON TURBULENCE OF A GAS STREAM. N. A. Fuks. *Zhur. Tekh. Fiz.* 21, No. 6, 704-7(1951) June. (Letter to the editor; in Russian)

The increase in effectiveness and decrease in hydraulic resistance of a cyclone dust extractor with increasing dust concentration apparently is explained by a decrease in turbulence of the gas stream effected by friction of the pulsating gas on dust particles.

190

FLOW OF GASES AND VAPOURS IN A POROUS MEDIUM AND ITS BEARING ON ADSORPTION PROBLEMS. PART I. THE STEADY STATE OF FLOW. PART II. TRANSIENT FLOW. R. M. Barrer and D. M. Grove. *Trans. Faraday Soc.* 47, 826-44(1951) Aug.

In Part I, a study was made of the steady state of flow of He, Ne, Ar, Kr,  $H_2$ ,  $O_2$ ,  $N_2$ ,  $NH_3$ ,  $CCl_4$ , and  $SO_2$  through a bed of small nearly spherical synthetic analcite crystals. Flow rates, permeabilities, Knudsen and Poiseuille contributions to permeability, and permeability constants were determined and used to test the applicability of several equations of flow. Significant deviations from the behavior suggested by these equations were observed, especially for vapors. In Part II, the transient state of flow was studied by the time-lag method. The same column was used as in Part I. 33 references.

## MATERIALS TESTING

191

Los Alamos Scientific Lab.

PRECISION MEASUREMENT OF UNIFORMITY OF MATERIALS BY GAMMA-RAY TRANSMISSION (abstract); by John N. Harris and Arthur I. Berman. [nd] Decl. Nov. 13, 1951. 1p. (AECD-3278; LADC-1056)

The uniformity of the product of thickness and density (i.e., mass per unit area) of materials of constant mass absorption coefficient is determined by measurements of the variation in  $\gamma$ -ray transmission. The radiation is detected with a scintillation detector and vibrating-reed electrometer. For a given incident intensity, maximum sensitivity is attained when a source is chosen which emits  $\gamma$  rays whose mean free path in the material under investigation equals the thickness. This optimum condition for

$Co^{60}$  radiation obtains for thicknesses of 3, 1, and  $\frac{1}{2}$  in. of Al, Fe, and U, respectively; using a 1-c source, variations of 0.01% in the uniformity of plates of these thicknesses have been measured. The method may be applied also to the scanning of curved surfaces and extended materials where the source and detector cannot permanently be fixed with respect to each other. For this latter case, the problem of compensating for the effect of source-detector misalignment is considered.

192

Oak Ridge National Lab.

INSTRUMENTATION FOR A PRECISION CREEP TESTING LABORATORY; by Joe Lundholm, Jr. Nov. 2, 1951. 34p. (ORNL-1044)

The design of a sixteen-machine precision creep-testing laboratory for determining the rate of permanent deformation that occurs in metals subjected to stress at high temperatures is discussed. Eight vacuum furnaces, six inert gas atmosphere furnaces, and two standard tube furnaces are provided. Electric proportional controllers are used to maintain the desired test-specimen temperature by adjusting the "percentage on-time" of the power to the furnace. Long-time stability of the temperature to within  $\pm 1^\circ C$  at any value up to  $1000^\circ C$  is obtained. A detailed analysis of the operation of this system is given. An emergency power supply is provided in event of power failure.

193

ELECTRICALLY EXCITED RESONANT-TYPE FATIGUE TESTING EQUIPMENT. Thomas J. Dolan. *ASTM Bull.* 175, 60-8(1951) July.

A new fatigue testing machine is described that is operated and controlled by simple electrical circuits. The loads are applied by inertia forces from two heavy masses between which is suspended the test specimen. The system operates as a "tuning fork" which subjects the test specimen to vibratory bending stresses; it is automatically excited electronically in resonance with the natural frequency of the assembly (usually 40 to 100 cps). Advantages and adaptability of the equipment for other uses are discussed briefly. Preliminary results are presented from flexural fatigue tests of round and of square specimens of 24S-T4 aluminum alloy to show the effect of shape of cross section on the fatigue strength. (auth)

## PUMPS

194

MODERN VACUUM PUMPS. D. R. Goddard. *J. Sci. Instruments*, Suppl. 1, 1-7(1951).

The two distinct classes of pump, the mechanical and the vapor pump, are discussed in a general rather than a detailed theoretical manner with a view to examining the factors influencing performance and the more important design features. The different types of rotary pump are compared and their performance examined in relation to the requirements of capacity, ultimate pressure and the pumping of condensable vapors. The mechanism of vapor pumps is discussed in relation to the design of ejectors and diffusion-condensation pumps. A comparison of oil and mercury pumps is made and the requirements of capacity, ultimate pressure and backing pressure characteristics discussed. (auth)

## TRACER APPLICATIONS

195

A STUDY OF TRACER METHODS FOR ASSESSING WEAR OF WIRE-DRAWING DIES. J. C. E. Button, A. J. Davies, and R. Tourret. *Nucleonics* 9, No. 5, 34-43(1951) Nov.

A technique has been developed for measuring die wear. A tungsten carbide die was irradiated with neutrons for one



week; a Cu wire was then drawn through the die, and debris on the drawn wire was detected by an autoradiographic technique. For a more quantitative measurement a G-M tube was inserted into a close-wound helix formed by a single length of wire. The 24-hr activity of  $W^{187}$  and the 5.3-yr activity of  $Co^{60}$  were used to determine the amounts of W and of Co deposited. The autoradiographs revealed three distinct types of wear deposits: (1) fairly uniform wear deposits showing as a general background along the positions occupied by the wires, tentatively attributed to Co; (2) discrete spots, of much greater intensity than the general background, occurring either singly or as nonuniform groups, tentatively attributed to particles of tungsten carbide; and (3) groups of uniformly spaced discrete spots, extending over  $\sim 1$  in. of wire, occurring occasionally. The wear appears to vary with order of drawing. There was no discrimination between lubricants.

#### VACUUM SYSTEMS

196

Hanford Works

A PHOTOELECTRIC TOEPLER PUMP CONTROL; by W. N. Carson, Jr. Oct. 25, 1951. 10p. (HW-22468)

A Toepler pump control using a photoelectric pick-up has been developed. The circuit is rugged, simple, and

safe. It is adaptable to uses wherein the control is remotely placed from the pump.

197

LA TECHNIQUE DU VIDE (Vacuum Technique). Maurice Leblanc. Paris, Librairie Armand Colin, 1951. 188p.

The essential features of the kinetic theory of gases, vacuum-producing apparatus, vacuum measurements, degassing of equipment, reduction and maintenance of vacuums, etc., are discussed. Although addressed principally to industrial technicians, the volume should also be of interest to research workers.

198

THE DESIGN OF INDUSTRIAL VACUUM SYSTEMS. T. S. Millen. J. Sci. Instruments, Suppl. 1, 7-10(1951).

After outlining the laws governing the flow of gases at low pressures and their relation to the performance of individual components, the author proceeds to discuss a trial design. The information required is discussed and the factors which influence the final choice of components are dealt with in some detail with special reference to the basic features and the influence of operating methods and conditions on the design. Systems of control are described and an indication is given of the methods by which automatic protection can be applied. (auth)

## MINERALOGY, METALLURGY, AND CERAMICS

199

Alfred Univ.

FUNDAMENTAL PROPERTIES OF METAL-CERAMIC MIXTURES AT HIGH TEMPERATURE (Periodic Status Report No. 27); W. B. Crandall, Director. July 31, 1951. 7p. (NP-3243)

Preliminary thermal shock experiments have been conducted on a number of porcelain balls, one group having a porosity of 12% and the other having a zero porosity, to determine the validity of the theory. Using the zero-porosity balls, a fine hairline crack instantly propagated causing complete fracture. In the higher porosity balls fine hairline cracks were very difficult to detect. Thus a statistical approach seems necessary. It was found that the structure of the aluminide intermetallics (Ni-Al, Cr-Al, and Mo-Al) are too complex to be determined by simple x-ray diffraction powder techniques. A method is described for obtaining solid-state diffusion curves using radioactive tracers.

#### CERAMICS AND REFRACTORIES

200

Pennsylvania State Coll.

REFRACTORY MATERIALS FOR USE IN HIGH-TEMPERATURE AREAS OF AIRCRAFT (Summary Report); by N. R. Thielke and E. C. Henry. July 1950. 51p. (AF-TR-6080)

201

[Institute of Engineering Research, Univ. of Calif., Berkeley]

[FIRST] PROGRESS REPORT; [SEPTEMBER 15, 1950, TO MAY 17, 1951]; by Joseph A. Pask. May 17, 1951. 7p. (COO-82)

An apparatus for measuring wettability of metals by glasses is described. Results of preliminary measurements of angle of contact (as a criterion of wettability) between molten glass and the surface of flat pieces of Au and Ag are discussed.

202

Institute of Engineering Research, Univ. of Calif., Berkeley  
FUNDAMENTALS OF GLASS TO METAL BONDING; I. ROLE OF SURFACE TENSION (First Technical Report); by David W. Mitchell, Stephen P. Mitoff, Victor F. Zackay, and Joseph A. Pask. Oct. 15, 1951. 46p. (COO-83)

This report is concerned with the role of interfacial and surface tensions or energies in the adhesion of glass to metal. It includes a summary of the methods of measuring surface tension of glasses and a review of selected experimental data reported in the literature on surface-tension measurements.

203

Naval Engineering Experiment Station, Annapolis  
TEST OF PFAUDLER COMPANY CERAMIC COATING FOR WET EXHAUST MUFFLERS AND PIPING; by Alan R. Schrader. Nov. 3, 1950. 20p. (EES-2A101734; U-16633)

204

Massachusetts Inst. of Tech.

THE MEASUREMENT OF THERMAL CONDUCTIVITY OF REFRACTORY MATERIALS; by F. H. Norton, W. D. Kingery, et al. Oct. 1, 1951. 20p. (NYO-600)

Results of measurements of the thermal conductivity at low and intermediate temperatures of magnesium aluminate spinel, mullite, MgO, ZnO, and  $Al_2O_3$  are presented graphically. Data on  $Al_2O_3$  up to  $1550^\circ$  have been obtained by using inductive heating. The pattern of heat flow and errors in the ellipsoidal test are discussed.

205

Massachusetts Inst. of Tech.

THE STUDY OF METAL-CERAMIC INTERACTIONS AT ELEVATED TEMPERATURES; by F. H. Norton and W. D. Kingery. Oct. 1, 1951. 14p. (NYO-3136)

A summary of the reactions of  $Al_2O_3$ ,  $ZrO_2$ , MgO,  $TiO_2$ ,  $ThO_2$ , and Be with Zr, Ti, Ni, Mo, Si, Be, and Nb at  $1400$  to  $1800^\circ C$  is presented in a table. Thermodynamic calculations of the free energy involved in the reactions are tabu-

lated. Graphs show the effect of composition on surface tension in the Fe-Ni system and the variation of contact angle of Fe-Ni alloys on  $ZrO_2$  with surface tension. Equipment for studying sintering of materials and a method of preparing NaCl spheres are described.

206

# ELECTRIC AND THERMOELECTRIC PROPERTIES OF PARTIALLY REDUCED (BLUE) TITANIUM DIOXIDE.

B. I. Boltaks, F. I. Vasinin, and A. E. Salunina. *Zhur. Tekh. Fiz.* 21, No. 5, 532-46(1951) May. (In Russian)

Specimens of  $TiO_2$  were partially reduced by streaming CO or  $H_2$  to compositions ranging from  $TiO_{1.805}$  to  $TiO_{1.985}$ . Specific electrical conductivities, thermal electromotive forces, and effects of temperature on these values were determined and are tabulated and graphed. The effective mass of the electron and its energy of dissociation in the lattice of the partially reduced  $TiO_2$  are discussed. 5 tables, 11 figures.

207

# NEW VARIETIES OF BARIUM TITANATE MONOCRYSTALS.

I. N. Belyaev, N. S. Novosil'tsev, A. L. Khodakov, and E. G. Fesenko. *Doklady Akad. Nauk S.S.S.R.* 78, No. 5, 875-7(1951) June 11. (In Russian)

Dielectric properties of  $BaTiO_3$  single crystals produced in various ways, including crystallization from  $BaTiO_3 + NaCO_3 + K_2CO_3$  or  $BaCO_3 + BaCl_2 + TiO_2$  melts in corundum, graphite, or Pt crucibles, are plotted from -180 to 500°C. Observed differences are discussed.

208

HIGH-TEMPERATURE REACTIONS IN THE SYSTEM TITANIUM CARBIDE-BORON CARBIDE. Harold M. Greenhouse, Oliver E. Accountius, and Harry H. Sisler. *J. Am. Chem. Soc.* 73, 5086-7(1951) Nov.

Titanium carbide and boron carbide are shown to react at temperature above 1920° to produce titanium diboride, carbon, and a higher boride of titanium of unknown composition. (auth)

209

THE ZIRCONIA-YTTRIA SYSTEM. Pol Duwez, Frank H. Brown, Jr., and Francis Odell. *J. Electrochem. Soc.* 98, 356-62(1951) Sept.

Phase relationships in the zirconia-yttria system were established up to 2000°C. The mechanism of stabilization of zirconia by an oxide of the yttria type is discussed in relation to the crystal structure of these two oxides. It is concluded that scandia, as well as other oxides of the rare-earth group from element 62 to 71, should stabilize zirconia by the same mechanism. Experimental results obtained on scandia, gadolinia, and samaria are tabulated. 11 references.

## CORROSION

210

National Academy of Sciences  
MINUTES OF THE SYMPOSIUM ON CORROSION;  
FEBRUARY 3 AND 4, 1949; Julius J. Harwood, Chairman.  
[nd] 174p. (NP-3092)

## GEOLOGY AND MINERALOGY

211

New York Operations Office, AEC  
MEASUREMENT AND INTERPRETATION OF THE ALPHA PARTICLE EMISSION FROM DRILL CORE TAKEN FROM REGIONS SURROUNDING CARNOTITE DEPOSITS; by R. F. Van Wye. July 25, 1951. 66p. (NYO-3450)

A region on the Colorado Plateau was chosen for investigating the feasibility of applying methods for the remote detection of carnotite ore by utilizing the peculiar radioactive characteristics of uranium. The prime tool was the

measurement and interpretation of alpha-particle emission from drill core samples taken in the region. The data were examined for gross variations; they were analyzed by statistical methods, and they were correlated with chemical analysis. This preliminary investigation showed that: There are detectable amounts of radioactive material (about 0.0003 to 0.003%) distributed through the rocks surrounding the carnotite ore deposits. No simple and neat patterns of distribution were found. The variation of alpha emission of samples within holes compared with the variation between holes had a small probability of occurring by chance. Both high-count samples and low-count samples were found close to ore. Nonuniform leaching of members of the uranium decay chains is indicated by the ratio of radium to uranium in the samples. Since the preliminary study shows the feasibility of setting up guides to be used along with other methods of exploration, a program for further research is outlined. The relationship of this program, which is only one part of a research program in raw materials exploration, to other programs is discussed, giving names of individuals, laboratories, and sites. (auth)

212

Division of Raw Materials, AEC  
PRELIMINARY BIBLIOGRAPHY ON URANIUM AND THORIUM AND RADIOACTIVE CARBONACEOUS DEPOSITS; Margaret Cooper, comp. Nov. 1951. 40p. (RMO-835; RMO-547(Rev.))

This bibliography, which supersedes RMO-547 (NSA 5-4765), consists of 204 items and represents a selected but not exhaustive listing of published literature, press releases, speeches, and open-file reports dealing with the nature of U and Th deposits, the problems associated with their exploration and development, and the manifestations of radioactivity or the presence of U in petroleum, petroleum waters, kolm, shales, and related carbonaceous deposits.

213

Geological Survey  
VEIN DEPOSITS OF URANIUM AT THE CARIBOU MINE, BOULDER COUNTY, COLORADO; by Robert U. King. [nd] 17p. (TEM-13A)

Radiometric traversing of accessible levels, geologic mapping of the area, and sampling of the Radium vein of the Caribou mine, Boulder County, Colo., are reported. Quartz-carbonate veins cutting intrusive tertiary porphyritic monzonite, contain galena, sphalerite, marmatite, and ruby silver as the ore minerals, and quartz, dolomite, and clayey gouge as the gangue. The Radium vein, containing pitchblende in addition, has a U content ranging from 0.001 to 1.45%. Ag and Pb accompanying the pitchblende may be sufficiently abundant to repay further prospecting of the vein to the east and at different levels.

214

Geological Survey  
TORBERNITE OCCURRENCE AT THE ROBINEAU CLAIMS, CLEAR CREEK COUNTY, COLORADO; by Robert U. King and Harry C. Granger. [nd] 5p. (TEM-24A)

All accessible mine workings and outcrops within an area of half a square mile of the Robineau Claims (including George Peabody, MacGregor, and Little Mac Claims), Clear Creek County, Colo., were traversed radiometrically. Torbernite and a radioactive mineral, tentatively identified as goethite, are associated with hydrous Fe oxides on fracture surfaces in pre-Cambrian granite and pegmatite. A composite sample from the George Peabody dump contained 0.013%  $U_3O_8$ .

215

CONTRIBUTION TO THE KNOWLEDGE OF THE GEOLOGY OF SIERRA PIRE-MAHUIDA AND ITS SPURS, N. E. OF



GASTRE, CHUBUT. Romeo Croce. Rev. inst. nacl. invest. cienc. nat., anexo museo argentino cienc. nat. "Bernardino Rivadavia," cienc. geol. **1**, 65-86(1950). (In Spanish)

A preliminary exploration among the granitic and volcanic formations of the northern part of the province Chubut, Argentina, showed that certain jasper opals and hyalites, included in basalts as veins and segregations, are uraniferous. In the opal, U seems to be present as an impregnation of the mineral; its content is less than 0.01%.

216

V POISKAX RADIYA (IN SEARCH OF RADIUM). D. I. Shcherbakov. Moscow, Gosgeolizdat, 1941. 132p. (In Russian)

During 1925 the author led a party prospecting for radioactive ores and mineral deposits in the valley of Fergana and the surrounding mountainous area bordering on China and Afghanistan. He recounts their adventures in a non-technical fashion. The author states that this area was the only major source of radioactive ore within the Soviet Union. The numerous photographs give an excellent picture of the barren, rugged terrain, which greatly resembles the American West. Use of a Schmidt-type  $\alpha$  electroscope in the field, distribution of radioactivity in a sample of tyuyamunite ore, and several representative ore locations are included in the illustrations.

217

EXTRACTION OF URANIUM FROM ORE CONCENTRATE. H. Chr. Neeb and K. Stokland. In Forsvarets Forskningsinstitutt Årbok III, 1950-1951, p.3-16. (In Norwegian)

The U for the Kjeller pile was obtained from a uraniferous pegmatite deposit at Einerkilen in Evje in the Setesdal, Norway. The process used to obtain pure  $U_3O_8$  from the ore concentrate is described. The ore was treated with warm dilute  $HNO_3$ , Ra was precipitated with  $Na_2SO_4$  after addition of  $Ba(NO_3)_2$ , and the U was precipitated as ammonium uranate, which was then transformed to  $U_3O_8$  at over 1000°C. Engineering problems involved in the acid treatment of the concentrate, slurry filtration, Ra removal, filtration of the uranate, and ignition to the oxide are discussed.

218

URANIUM AS FISSIONABLE MATERIAL IN ATOMIC REACTORS. K. Stokland and H. Chr. Neeb. In Forsvarets Forskningsinstitutt Årbok III, 1950-1951, p.17-27. (In Norwegian)

In connection with the production of fuel for the first Norwegian reactor, a brief summary of the methods described in the literature for refining U oxides and producing U metal from  $UO_2$  is given. The actual process used for the Kjeller pile is not discussed in this paper.

219

LABORATORY EXPERIMENTS ON BENEFICIATION OF SOVITE. O. G. Gjosteen. In Forsvarets Forskningsinstitutt Årbok III, 1950-1951, p. 29-41. (In Norwegian)

The sövite ore located at Söve, Ulefoss, Norway, is of interest because of its Nb content (up to 0.35%  $Nb_2O_5$ ). Some experiments on magnetic concentration are described.

220

DETERMINATIONS OF THE ABSOLUTE AGE OF THE PITCHBLLENDE OF SHINKOLOBWE, KATANGA. L. Cahen. Bull. soc. belge géol. paléontol. hydrol. **60**, No. 1, 80-7(1951) July 15. (In French)

Published determinations of the age of the Shinkolobwe, Belgian Congo, pitchblende by Pb/U ratios are examined critically. An age of  $(600 \pm 20) \times 10^6$  yr is accepted.

221

THE AGE OF THE SHINKOLOBWE PITCHBLLENDE AND THE CAMBRIAN-PRECAMBRIAN BOUNDARY. L. Cahen. Bull. soc. belge géol. paléontol. hydrol. **60**, No. 1, 88-97(1951) July 15. (In French)

Problems involved in dating the base of the Cambrian formations by correspondence to the uraniferous mineralization of known date at Shinkolobwe, Belgian Congo, are discussed.

222

CHRONOLOGY OF THE ANTE-KARROO FORMATIONS EAST OF THE CONGO BASIN. L. Cahen. Bull. soc. belge géol. paléontol. hydrol. **60**, 97-113(1951) July 15. (In French)

Included in this discussion of correlation between the formations of the region and the effects of various orogenies is a consideration of the stratigraphic position of the Katanga pitchblende.

## METALS AND METALLURGY

223

National Research Corp. PREPARATION OF DUCTILE ZIRCONIUM: FINAL REPORT; DECEMBER 30, 1948, TO MAY 20, 1950; by W. O. DiPietro, G. R. Findlay, and J. H. Moore. Issued Sept. 20, 1950. Decl. Nov. 16, 1951. 94p. (AECD-3276; NR-24)

Progress in the preparation of ductile Zr by an arc-dissociation (thermal-reduction) process from  $ZrCl_4$ ,  $ZrBr_4$ , and  $ZrI_4$ , with particular attention to the iodide, and in development of a continuous Zr casting process is described in detail. All apparatus is illustrated. A 120-lb batch unit for preparation of  $ZrI_4$  by direct iodination of crude Zr sponge is described. Conversions to the metal of 16.4 to 97.7% were accomplished by the arc dissociation of  $ZrI_4$ , depending on conditions of operation, and a maximum yield of 255 g/hr was achieved with an expenditure of 30 kwh/lb of metal. Continuous casting of arc-melted Zr appears feasible over a pressure range of 0.5  $\mu$  of Hg to 1 atm. Some consideration was given to the drip-melting process. Conclusions as to applicability of the processes to production are only tentative, with additional study suggested. 24 figures.

224

Carnegie Inst. of Tech. FABRICATION OF BERYLLIUM METAL; by E. Creutz and D. Gurinsky; Carnegie Inst. of Tech. and Brookhaven National Lab. Mar. 28, 1951. 10p. (AECD-3279; ANL-HDY-696)

The development of suitable techniques for extrusion, forging, and welding of Be is briefly reviewed. Conditions, such as temperature, pressure, and die shape, affecting extrusion were investigated at the Wolverine Tube Division of Calumet and Hecla Copper Company, and their experiments which led to the first successful extrusion in 1944 are briefly summarized. Results of experiments at Westinghouse, Bloomfield, N. J., on forging of Be are discussed.

225

Argonne National Lab. ANODIZING OF ZIRCONIUM; by R. D. Misch. Oct. 1951. 26p. (AECU-1701; UAC-447)

The voltage-current-time relations were determined for anodizing Zr under varying conditions of electrolyte concentration and temperature. The critical voltages for anodizing zirconium vary from 50 to 200 v at 1 ma/cm<sup>2</sup> in 20% oxalic acid at 100°C. The wide variation depends upon metal purity. The critical voltage may be raised by the presence of impurities increasing oxide film permeability and lowered by the presence of impurities such as cobalt which catalyze oxygen evolution. Continued oxide growth occurs in solutions of nitric acid above 5% and the distinction between barrier and porous oxide disappears. The critical voltages of barrier layers and the rate of formation of thick oxide films in nitric acid do not show any relation-

ship. Residual current densities upon anodizing at 5 v in concentrated nitric acid vary from 0.009 to 0.02 amp/cm<sup>2</sup> and the slope of the I vs. log time curve is  $-0.034 \pm 0.008$ .

226

Atomic Energy Research Establishment, Harwell, Berks (England)  
PLASTIC DEFORMATION OF URANIUM; by R. W. Cahn. July, 1951. 56p. (AERE-M/R-740)

The crystallography of twinning, slip, and kinking in  $\alpha$ -uranium was studied. Very coarse-grained U was used. This called for a new design of x-ray camera, which is briefly described. Techniques used for finding the several slips, twinning, and kink-band planes; the slip directions; and the directions and magnitudes of the twinning shears are fully described. Observed interactions of twins and their applications to the conformation of twin directions are discussed. Twinning elements found are presented in tabular form. Observations on the influence of temperature on slip and twinning, the effect of annealing on twins and on the pseudo-cleavage sometimes associated with twins, are set forth. A general discussion of the phenomenon of mechanical twinning includes a discussion of the choice of twinning elements, the shapes of twins, stress criterion for the inception of twinning, the influence of temperature and other factors on twinning, and the effect of annealing on deformation twins. 44 references. 44 figures.

227

Battelle Memorial Inst.  
WELDING OF MOLYBDENUM; by W. H. Kearns, H. B. Goodwin, D. C. Martin, and C. B. Voldrich. Sept. 1, 1951. 35p. (BMI-703)

An investigation has been under way at Battelle Memorial Institute since 1949 to find the causes of brittleness in molybdenum welds and to find means of eliminating these causes. It was found that ductile upset welds can be made in high-purity molybdenum if contamination of the welds is prevented. Thorough cleaning of the faying surfaces prior to welding and shielding the welds from the air during welding are necessary. Upset welds with some ductility can be made in commercial arc-cast molybdenum that is deoxidized with carbon. A postweld heat-treatment will produce some ductility in upset welds in commercial-swaged powder-metallurgy molybdenum, but porosity is a serious problem. (auth)

228

Dow Chemical Co.  
PREPARATION OF HIGH PURITY MAGNESIUM AND A STUDY OF THE EFFECT OF NON-METALLIC AND ALKALI METAL IMPURITIES OF THE CORROSION CHARACTERISTICS OF PURE MAGNESIUM; 7TH QUARTERLY REPORT; JUNE 1, 1951-AUGUST 31, 1951. [nd] 46p. (COO-78)

Phosphorus improves the corrosion resistance of Mg-Fe alloys in the "as cast" state when the Fe content is above the tolerance limit of 80 ppm. At low Fe values there may possibly be a slight detrimental effect due to P. A high-temperature solution heat-treatment with water quench noticeably improves the corrosion resistance of both Mg-Fe and Mg-Fe-P alloys when the Fe content is above the tolerance limit. Photomicrographic studies have confirmed the existence of a maximum in the plot of corrosion rate vs. Fe content in Mg-Fe binary alloys. The maximum is caused by wide dispersion of Fe in Mg. A comparison of commercially pure Mg and sublimed high-purity magnesium was made in the following corrosion mediums: 1N HCl, HAc + NaAc, 1N HCl + 3% NaCl, and 3% NaCl. The high-purity Mg exhibited greater corrosion resistance than the commercially pure Mg in all cases except the acetic acid-sodium acetate solution.

229

Towne Scientific School, Univ. of Pennsylvania  
PREPARATION OF SINGLE CRYSTALS OF BERYLLIUM AND ZIRCONIUM; A STUDY OF MECHANICAL PROPERTIES; QUARTERLY REPORT; JANUARY 1, 1951, TO APRIL 1, 1951; by R. M. Brick, H. T. Lee, and H. Greenwald. [nd] 7p. (NP-3112)

Compression stressing of Be single crystals at room temperatures has given, for certain orientations, pure slip and for other orientations, pure twinning. The critical shear stresses for these deformations have been obtained and are reproducible to within 10%. The effects of oxygen and nitrogen on the microstructure, hardness and lattice parameters of iodide Zr have been determined. Solution of oxygen displaces the second phase usually observed in iodide Zr (Foote) from the surface inward. Nitrogen is soluble in alpha Zr to less than 0.5 at. %. Neither oxygen nor nitrogen affect the lattice parameters of Zr sufficiently to use parameters as an analytical tool. (auth)

230

General Electric Co.  
SOME CRYSTALLOGRAPHY PHENOMENA ASSOCIATED WITH GRAIN GROWTH IN COPPER; by M. Sharp and C. G. Dunn. Sept. 26, 1951. 8p. (NP-3469; 50TP120-1)

When a large crystal of Cu which is growing at the expense of a fine grained matrix contains subboundaries representing orientation differences of the order of  $\frac{1}{2}$  degree, the forward advance of the grain boundary is retarded at its intersections with subboundaries. Second-order twins in Cu form straight boundaries which have an appearance similar to coherent first-order twin boundaries. The direction of these boundaries corresponds to a {111} plane of one grain and a {115} plane of the other. Another favored direction for the boundary between second-order twins is near to a {223} plane of one grain and a {551} plane of the other. (auth)

231

Institute of Engineering Research, Univ. of Calif.  
THE EFFECT OF ALLOYING ELEMENTS ON THE ELEVATED TEMPERATURE PLASTIC PROPERTIES OF ALPHA SOLID SOLUTIONS OF ALUMINUM (Eleventh Technical Report); by O. D. Sherby, R. A. Anderson, and J. E. Dorn. Dec. 15, 1950. 73p. (NP-3474; U-15651)

This material was published in *J. Metals* (N.Y.) 3, 643-52(1951) and abstracted in *Nuclear Science Abstracts* as NSA 5-6215.

232

Naval Research Lab.  
LIQUID METALS; THERMAL CONDUCTIVITY MEASUREMENTS; by Curtis T. Ewing. Oct. 23, 1951. 9p. (NP-3481; 3230-135A/51)

Results are presented of experimental measurements and calculations of thermal conductivity of stainless steel (type 304), Na, and Na-K alloy (56.5 wt. % K) at temperatures from 200 to 815°C.

233

California Inst. of Tech.  
ALLOTROPIC TRANSFORMATION IN TITANIUM-ZIRCONIUM ALLOYS (Second Technical Report); by Pol Duwez. Oct. 1951. 16p. (NP-3491)

In Ti-Zr alloys, the transformation from the high-temperature body-centered cubic  $\beta$  solid solution to the low-temperature hexagonal close-packed  $\alpha$  solid solution takes place, at least partially, for all compositions and for rates of cooling as high as 8000°C/sec. This transformation, however, is not complete, and the amount of the  $\beta$  solid solution which is retained is maximum in alloys containing 50 at. % (auth)



234

Pennsylvania State Coll.

THE CORROSION OF ZIRCONIUM; by L. E. Colteryahn, W. E. Ray, and H. J. Read. Sept. 31, 1951. 14p. (NYO-836)

Thin films of Zr which are to be used in corrosion studies have been prepared by cathodic sputtering. Dense, continuous films were obtained in 10 hr at a cathode current density of 0.014 ma/mm<sup>2</sup> in an atmosphere of Kr at 140 to 180  $\mu$  pressure. The apparatus used is diagramed. Furnaces for contamination of pure films with gaseous impurities and for the corrosion of specimens in gaseous corrosive atmospheres and the procedures to be used are described.

235

Pittsburgh Univ.

SOME CRYSTALLOGRAPHIC CHARACTERISTICS OF THE CADMIUM RICH MAGNESIUM-CADMIUM ALLOYS BETWEEN 25 AND 300°C; PROGRESS REPORT FOR JULY 1, 1951-OCTOBER 1, 1951; by W. E. Wallace and D. A. Edwards. Oct. 5, 1951. 18p. (NYO-945)

The unit cell dimensions of pure Cd and Mg-Cd alloys containing 90.6, 78.0 and 75.2 at. % Cd have been determined between 25 and 300°C. Dehlinger's proposed structure for the MgCd<sub>3</sub> superlattice was verified. The order-disorder transition temperature in MgCd<sub>3</sub> as determined by its diffraction characteristics was found to be about 65°C. The alteration in structural characteristics of MgCd<sub>3</sub> in the vicinity of its order-disorder Curie point has been determined and thermal expansivities of this alloy and the others have been reported. From the diffraction patterns a provisional estimate of the terminal solid solubility limits of Mg in Cd between 25 and 65°C has been made. The percentage of Schottky defects has been computed and compared with the values expected from the anomalous entropy behavior of high-Cd Mg-Cd alloys. (auth)

236

Horizons, Inc.

THE PRODUCTION OF ZIRCONIUM BY FUSED SALT ELECTROLYSIS; TECHNICAL PROGRESS REPORT; FIRST QUARTER; JUNE 1 TO AUGUST 31, 1951; by Merle E. Sibert and Morris A. Steinberg. Aug. 30, 1951. 28p. (NYO-3116)

A method for producing high-purity Zr metal powder by electrolysis of fused salts has been developed. This method consists in electrolyzing fused mixtures of K<sub>2</sub>ZrF<sub>6</sub> and NaCl under an inert atmosphere of argon at approximately 1000°C. A variety of conditions have been investigated and the optimum conditions of current density, voltage, temperature, cathode material and cathode spacing have been determined. A procedure for washing and leaching the deposited metal has been elucidated. Some samples obtained have been analyzed for purity. A Zr content of 99.7% purity has been obtained with an O content as low as 0.09%. (auth)

237

Research and Development Board  
SYMPOSIUM ON TITANIUM; 8 AND 9 NOVEMBER 1950. [nd] 107p. (RDB-331/1; Digest Series No. 43)

The following subjects were discussed in this symposium on Ti: the trends of the electric power industry in the United States and their relation to Ti production; possibilities for use of Ti in military equipment and ships; development of Ti alloys; metallurgy and properties of Ti and Ti alloys; programs being carried out by various military departments, other government agencies, and industries interested in Ti.

238

METALLOGRAPHY OF ALLOYS OF TITANIUM WITH OXYGEN, CARBON, AND NITROGEN. Thomas Redden and Mary Jane Field. *Steel* 129, No. 21, 88-90(1951) Nov. 19.

Alloys of Ti with O<sub>2</sub>, N<sub>2</sub>, and C were studied to determine the effect on the transformation temperature of Ti. Physical test results and microstructures following various heat-treatments are tabulated. The O<sub>2</sub> and N<sub>2</sub> alloys indicate complete solubility of 0.25% of these elements in both the  $\alpha$  and  $\beta$  phases of Ti. The effects of the heat-treatment upon the crystalline structure of the alloyed and unalloyed Ti samples are shown by photomicrographs. The impurities present in unalloyed Ti give the typical Widmanstätten structure on quenching from above the critical temperature.

239

A POSSIBLE EXPLANATION OF THE INCREASE OF THE ELECTRICAL RESISTANCE OF THIN METAL FILMS AT LOW TEMPERATURES AND SMALL FIELD STRENGTHS. C. J. Gorter. *Physica* 17, 777-80(1951) Aug.

An explanation is tentatively suggested for the increase in resistance of thin metal films at low temperatures and small electrical field strengths. The film is supposed to consist of separate grains or blocks, and the energy required for separation of a positive and a negative charge, located on different grains, is compared with the thermal energy kT. The resulting picture seems to describe in principle the observed increase of resistance. (auth)

240

MATERIALS OF CONSTRUCTION VS. HYDROGEN PEROXIDE. Morgan M. Hoover. *Chem. Eng.* 58, 263-71(1951) Oct.

This review includes a revised article by J. S. Reichert and R. H. Pete followed by short articles by other authors. The resistance of the following materials to corrosion by H<sub>2</sub>O<sub>2</sub> and the effect of these materials on the stability of H<sub>2</sub>O<sub>2</sub> solutions are discussed: Al, stainless steel, Sn, Ta, Pb, Fe, Cu and Cu alloys, rubber, plastics, wood, Transite, concrete, Ni and Ni alloys, high-Si irons, glass, Worthite, silicones, Chlorimets, carbon and graphite, cements, and Durimet 20.

241

THE VARIATION OF THE RESISTIVITY OF SOME METALS WITH ELASTIC DEFORMATION. M. J. Druyvesteyn. *Physica* 17, 748-60(1951) Aug.

The variation of the resistivity with elastic deformation of Cu, Ag, Au, Al, Mo, W, Pt, and some alloys was measured on wires and on foils. In case of Al single crystals were prepared and all three crystal constants of the tensor, giving the relation between the relative variation of the resistivity and the deformation, could be determined. In the case of Cu, Ag, and Au, foils with a preferred orientation were used. From the measurements on these foils the anisotropy of Cu, Ag, and Au could not be determined; hence, it was not possible to calculate exactly the above-mentioned constants for these metals. The product of the anisotropy and the degree of the texture of the foil was determined. (auth)

242

ON THE STRUCTURE OF THE ALLOY OF NICKEL WITH ALUMINUM IN THE  $\beta$ -PHASE REGION AT HIGH TEMPERATURES. L. N. Guseva and E. S. Makarov. *Doklady Akad. Nauk S.S.S.R.* 77, No. 4, 615-16(1951) Apr. 1. (In Russian)

X-ray-diffraction data are tabulated for the  $\beta$  phase quenched from 60 to 66.6 at. % Ni-Al at 1340°C. Comparison with calculated intensities indicate that this phase is the body-centered tetragonal Ni<sub>3</sub>Al<sub>2</sub>.

243

REGION OF PRIMARY CRYSTALLIZATION IN PHASE Q OF THE Al-Cu-Mg SYSTEM. M. S. Mirgalovskaya. *Doklady Akad. Nauk S.S.S.R.* 77, No. 6, 1027-30(1951) Apr. 21. (In Russian)

The portion of the Al-Cu-Mg phase diagram including phase Q (450 to 530°C, 30 to 80% Al, 60 to 80% Mg, and 0 to

20% Cu) is shown, and all transitions to this phase are discussed.

244

X-RAY INVESTIGATION OF AGING OF ALUMINUM ALLOYS. II. APPLICATION OF X-RAY PHOTOGRAPHY AT LOW TEMPERATURES TO THE STUDY OF AGED ALLOYS. Yu. A. Bagaryatskiĭ, E. V. Kolontsova, and N. V. Rusakova-Lukovskaya. *Zhur. Tekh. Fiz.* **21**, No. 6, 658-62(1951) June. (In Russian)

A low-temperature camera for studying oriented, stationary monocrystals by monochromatic x radiation is described. X-ray-diffraction photographs of aged Al-Cu and Al-Cu-Mg monocrystals taken at 82 to 83°K with Rh radiation are shown and discussed.

245

DYNAMIC COEFFICIENTS UNDER CONCENTRATED STRESS. V. N. Danilov. *Doklady Akad. Nauk S.S.S.R.* **78**, No. 6, 1135-6(1951) June 21. (In Russian)

Dynamic coefficients, relating the energy of a blow to the energy of static pressure required to give the same depth of impression of a ball point, are presented graphically, but not tabulated, for Al, Pb, Sn, Pb-Sn alloys, Cu, and soft steel annealed at their recrystallization temperatures. Dynamic coefficients for Al, Cu, and soft steel previously cold-worked to 0 to 60% reduction also are plotted.

246

MELTING AND SINTERING OF METALS IN VACUO. E. D. Malcolm. *J. Sci. Instruments*, Suppl. **1**, 63-6 (1951).

The advantages and applications of melting and sintering in a vacuum are surveyed. The various problems peculiar to the use of a furnace in a vacuum enclosure, and the design of such a furnace suitable for melting 50 to 100 lb of steel are discussed. (auth)

247

X-RAY-DIFFRACTION AND ELECTRON-MICROSCOPIC ILLUSTRATIONS OF PLASTIC DEFORMATION OF ALUMINUM MONOCRYSTALS. E. V. Kolontsova. *Zhur. Eksptl'. i Teoret. Fiz.* **21**, No. 7, 821-5(1951) July. (In Russian)

Experimental results are presented indicating that the process of plastic deformation accompanies recrystallization in regions adjoining slip planes. 9 figures.

248

ON THE MECHANISM OF INTERGRANULAR CORROSION AND CORROSION UNDER TENSION OF ALUMINUM-MAGNESIUM AND ALUMINUM-ZINC-MAGNESIUM ALLOYS. Pierre A. Jacquet. *Compt. rend.* **233**, 871-3(1951) Oct. 15. (In French)

The  $AlCl_3$  formed by the action of the  $Cl^-$  ions of neutral NaCl solution on the anodic regions (electronegative phase and cold-worked structure) of Al-Mg or Al-Mg-Zr (zicral) alloys undergoes hydrolysis, which liberates free HCl. The acid vigorously attacks these regions with formation of  $H_2$ . Mechanical stress accelerates the attack by favoring access of the electrolyte to the base of fissures. 2 figures.

249

THE STRUCTURE OF  $ZrMo_2$ . Pol Duwez and Charles B. Jordan. *J. Am. Chem. Soc.* **73**, 5509(1951) Nov. (Communication to the editor)

Powder patterns of alloys thought to be  $ZrMo_2$  and  $ZrMo_3$  were found to be identical except for a few weak lines. The patterns agreed with relative intensities calculated on the assumption that the face-centered cubic phase is  $ZrMo_2$  with the C15 structure. It is proposed that the intermediate phase in the ZrMo system has the ideal stoichiometric composition  $ZrMo_2$  and the C15 crystal structure, and that there is no  $ZrMo_3$  phase.

250

GRAIN REFINEMENT OF ALUMINUM-SILICON (5% Si) AND ALUMINUM-SILICON-MAGNESIUM (7% Si, 0.3% Mg) CASTING ALLOYS. Vincent DePierre and Harold Bernstein. *Trans. Am. Soc. Metals* **43**, 635-43(1951).

Small rivet-shaped castings of Al-Si alloys, containing graduated amounts of refining elements, were made in a pre-heated graphite mold. The castings were sectioned, polished, and macroetched, and their grain sizes measured. The added elements had similar effects upon grain size of the two alloys tested. B, Nb, Ti, Zr, Ta, Mo, W, Cr, and Be, in that order of effectiveness, refined the grain size of the two alloys. Boron produced its maximum effect at about 0.05% concentration by weight.

TRACER APPLICATIONS

251

Massachusetts Inst. of Tech.

THE ADAPTATION OF TRACER TECHNIQUES TO MINERAL ENGINEERING PROBLEMS; PROGRESS REPORT. Oct. 31, 1951. 64p. (NYO-879; MITS-13)

Progress is reported on the following research topics: adsorption of dodecylamine acetate on hematite; flotation study of minerals, particularly zinc minerals; using radioactive hexyl mercaptan and related problems; depression of pyrite in flotation; geochemical studies; zeta potential measurements in flotation systems; adsorption of xanthate on pyrite; reactivity of the double bond in oleic acid during the process of flotation; and adsorption of radionuclides on minerals for ore beneficiation.

## PHYSICS

252

Knolls Atomic Power Lab.

CATHODIC SPUTTERING FOR MICRO-DIFFUSION STUDIES; by Thomas F. Fisher and C. E. Weber. [nd] 16p. (AECU-1712)

A method based on sputtering of metal from the cathode of a gas glow-discharge tube has been developed to allow uniform removal of microlayers of metal from cylindrical specimens and is being applied to diffusion studies by chemically analyzing the sputtered metal caught on a collecting anode. Preliminary experiments have been com-

pleted and the results obtained agree well with the theories on the mechanism of cathode sputtering. It was noted that the specimen must be supported on both ends in order to achieve axially uniform metal removal. Results on the sputtering rates for Be, Mg, Al, Cu, Zr, Ti, and Ni are reported. The sputtering of two alloys has been investigated; stainless steel (type 347) sputtered uniformly, however, the sputtering rates of the component atoms are probably quite similar. A sample of 70-30 brass, on the other hand, also sputtered uniformly even though Zn is more volatile than Cu.



253

Research Lab. of Electronics, Mass. Inst. of Tech.  
ELECTROMAGNETIC RESONANT BEHAVIOR OF A CON-  
FOCAL SPHEROIDAL CAVITY SYSTEM IN THE MICRO-  
WAVE REGION (Technical Report No. 206); by J. C. Simons  
and J. C. Slater. May 31, 1951. 4p. (NP-3472)

The electromagnetic resonance of a small spheroidal ob-  
ject in a large spheroidal cavity is investigated. This ap-  
proximates the case of a thin needle-like antenna in a large  
cavity. It is shown that this needle, if thin enough, shows  
marked resonant properties, in that when the cavity is  
tuned to a resonant frequency defined by the needle, the  
magnetic field on the surface of the needle is greatly en-  
hanced. This property can be used in a practical way in  
measuring surface impedance of the material of which the  
needle is composed; at resonance most of the loss in the  
cavity is located at the surface of the needle and depends on  
the material of which it is composed. (auth)

254

Radiation Lab., Univ. of Calif.  
RAPID ESTIMATION OF VARIATION OF EQUILIBRIUM  
CONSTANTS OR VAPOR PRESSURE WITH TEMPERATURE;  
by LeRoy A. Bromley. Sept. 28, 1951. 12p. (UCRL-1406)

Nomographs have been constructed by which it is possible  
to estimate rapidly the change in equilibrium constant for any  
reaction with temperature with a minimum of actual data  
required. The magnitude of the errors to be expected in the  
use of the method may also be estimated. (auth)

255

EXPERIMENTS ON THE PRODUCTION OF VERY LOW  
TEMPERATURES BY TWO-STAGE DEMAGNETIZATION.  
J. Darby, J. Hatton, B. V. Rollin, E. F. W. Seymour, and  
H. B. Silsbee. *Proc. Phys. Soc. (London)* **64A**, 861-7(1951)  
Oct.

A two-stage demagnetization apparatus employing a  
superconducting wire as the thermal switch between the  
stages is described. Temperatures in the region of  $0.003^\circ$   
K. have been obtained using a magnetic field of only 4,200  
gauss. The problem of thermal insulation was investigated  
and the residual heat inflow after demagnetization was  
reduced to one erg/min. The possibility of employing a  
superconducting switch in cyclical magnetic cooling systems  
and in nuclear demagnetization is discussed. (auth)

## ASTROPHYSICS

256

Ames Lab.  
TRANSITION PROBABILITIES; III. DIPOLE VELOCITY  
COMPUTATIONS FOR  $C_2$  AND  $N_2$ ; THE QUESTION OF  
DEGREE OF HYBRIDIZATION; by Harrison Shull. Sept.  
4, 1951. 23p. (ISC-162)

Previous computations of transition probabilities for  
hydrogen using the dipole-velocity operator are here ex-  
tended to the diatomic molecules  $C_2$  and  $N_2^+$ , with particular  
reference to the former. Whereas previous calculations  
have shown the dipole-length method to be relatively insen-  
sitive to the effective nuclear charge, the present computa-  
tions show great sensitivity of the dipole-velocity method  
to the ratio of the effective Z of the bonding orbital to the  
antibonding orbital. The results are less sensitive to the  
absolute magnitude of the Z's. The results are discussed  
with respect to reasonable assignments for the degree of s  
and p $\sigma$  hybridization of the respective orbitals and with  
respect to reasonable choices for the effective Z values.  
It is concluded that the degree of hybridization is most  
probably considerably higher than previously estimated.  
The dipole-velocity method is a promising one for further  
development.

## COSMIC RADIATION

257

ASSOCIATED PENETRATING PARTICLES OF COSMIC  
RAYS UNDERGROUND. H. J. J. Braddick, W. F. Nash, and  
A. W. Wolfendale. *Phil. Mag.* (7) **42**, 1277-88(1951) Nov.

Two cloud chambers have been used at a depth under-  
ground equivalent to 26 m of water in a study of the pen-  
etrating cosmic ray particles. Pairs of associated pene-  
trating particles have been observed originating in lead  
plates in the chamber and also entering it from above. It is  
considered that the process is one in which a  $\mu$  meson pro-  
duces a penetrating secondary of mean energy  $\sim 10^9$  ev, the  
penetrating secondary being either a  $\mu$  meson or a  $\pi$  meson.  
The cross section for the process is estimated to be about  
 $5 \times 10^{-29}$  cm<sup>2</sup> per nucleon for lead and of the same order of  
magnitude for sandstone. (auth)

258

THE ABSORPTION OF THE FOTONIC COMPONENT OF  
COSMIC RADIATION IN DIFFERENT MATERIALS.  
J. Clay and G. Klein. *Physica* **17**, 858-64(1951) Sept.

Absorption of high-energy photons in cosmic radiation  
was measured in Pb, Sn, Fe, Al, C, and paraffin. It was  
possible to distinguish between instances where the photon  
produced one secondary electron (a Compton electron) and  
the instances of two or more secondary electrons (pair  
formation). Absorption coefficients are given for the rays  
producing either effect, and in the former case the propor-  
tionality of this coefficient with Z was tested. The absorp-  
tion of the secondary electrons also was tested, from which  
the energy spectrum of the photons was estimated. The  
frequency of the different angles between the secondary  
electrons was measured, and a frequency relation of the  
occurrence of 2, 3, 4, and 5 secondary particles was  
determined. (auth)

259

NUCLEAR TRANSMUTATIONS PRODUCED BY COSMIC-  
RAY PARTICLES OF GREAT ENERGY. PART VI.  
EXPERIMENTAL RESULTS ON MESON PRODUCTION.  
PART VII. INTERPRETATION OF THE EXPERIMENTAL  
RESULTS. U. Camerini, J. H. Davies, P. H. Fowler,  
C. Franzinetti, H. Muirhead, W. O. Lock, D. H. Perkins,  
and G. Yekutieli. *Phil. Mag.* (7) **42**, 1261-76(1951) Nov.

An analysis has been made of the secondary particles  
ejected from nuclear disintegrations observed in electron-  
sensitive emulsions exposed to the cosmic radiation at  
68,000 ft. Scattering and grain-density measurements have  
been carried out on the tracks of 2000 particles associated  
with these stars. In addition, the grain density and angular  
distribution of 3070 shower particles and 1508 "gray"  
tracks have been measured. For 200 stars, the energy of  
the primary particle which produced the disintegration was  
measured. A detailed analysis was made of such events.  
Single fast  $\pi$  mesons of kinetic energy less than 1 bev are  
found to interact strongly with nuclear matter. An estimate  
of the frequency of occurrence of neutral mesons was made  
from a consideration of the energy balance in stars of low  
multiplicity,  $\eta_s$ .

The observations presented in the preceding Part are  
analyzed and compared with the current theories of meson  
production. In making the analyses, account is taken of the  
interaction with the parent nucleus both of the recoil  
nucleons and the created mesons. It is found that the ob-  
servations do not provide decisive evidence in favor of  
either plural or multiple meson production. The experi-  
mental results can be explained in terms of either the  
multiple theory with secondary generation of mesons, or  
the plural theory assuming many-body collisions. (auth)  
(See also NSA 4-4310.)

- 260  
EXPERIMENTS ON COMPARATIVE ABSORPTION IN HYDROGEN AND CARBON OF PARTICLES PRODUCING ELECTRON-NUCLEAR SHOWERS. B. I. Verkhovskii, N. A. Dobrotin, I. I. Levintov, and G. N. Khodakov. *Doklady Akad. Nauk S.S.S.R.* 77, No. 6, 1007-9(1951) Apr. 21. (In Russian)
- 261  
SPECTRUM OF THE IONIZING PARTICLES OF THE SOFT AND HARD COMPONENTS OF COSMIC RADIATION. N. A. Dobrotin, Ya. I. Graevskaya, N. L. Grigorov, S. I. Nikol'skii, and I. D. Rappoport. *Doklady Akad. Nauk S.S.S.R.* 77, No. 4, 599-602(1951) Apr. 1. (In Russian)
- 262  
THE ENERGY SPECTRUM OF THE SOFT (ELECTRON) PART OF COSMIC RADIATION FOUND BY ABSORPTION IN Pb AND Al. J. Clay and E. Van Alphen. *Physica* 17, 711-14(1951) July.  
The absorption of cosmic radiation was measured in Pb and Al. From the difference the differential spectrum of the electron component was found to be  $dN = N_0 E^{-1.50} dE$  up to  $E = 10^8$  ev. For energies above  $10^8$  ev the relation was  $dN = N_0 E^{-2.5} dE$ . The value found from the absorption in Fe and C was  $dN = N_0 E^{-1.35} dE$ .  
In a total of 261 particles absorbed in 10 cm Pb, 52 were electrons and 9 were mesons. (auth)
- 263  
ON THE DISINTEGRATION OF PARTICLES PRODUCING ELECTRON-NUCLEAR SHOWERS. S. A. Azimov, V. F. Vishnevskii, and N. I. Khil'ko. *Doklady Akad. Nauk S.S.S.R.* 78, No. 2, 231-4(1951) May 11. (In Russian)  
The coincidence-counter arrangement used in this experiment is shown, and the absorption in air and water of the particles producing electron-nuclear showers is tabulated and plotted.
- 264  
THE PROPERTIES OF NEUTRAL V-PARTICLES. R. Armenteros, K. H. Barker, C. C. Butler, and A. Cachon. *Phil. Mag.* (7) 42, 1113-35(1951) Oct.  
In a cloud-chamber investigation at 2867 m altitude 70 V tracks due to the decay of neutral V particles have been observed. An analysis has been made on the basis of the two-body decay processes:  $V_0^+ \rightarrow p^+ + \pi^-$  and  $V_0^0 \rightarrow \pi^+ + \pi^-$ , and it is concluded that the present limited data are consistent with these two processes. The ratio of the numbers of the two types of V particles is found to be  $V_0^+/V_0^0 = 1.6 \pm 0.5$ , and accurate mass estimates have been obtained for 12 examples of the first type of decay and for 8 examples of the second type. The results are consistent with the unique mass values  $(2203 \pm 12)m_e$  and  $(796 \pm 27)m_e$ , respectively. No evidence was found for the presence of neutral secondary particles. Preliminary investigations of the differential momentum spectra do not appear to be in agreement with symmetrical three-body schemes involving a nucleon and two mesons. Eight photographs are shown.
- 265  
PENETRATING SHOWERS PRODUCED IN BERYLLIUM AT SEA LEVEL. W. Y. Chang, G. del Castillo, and Leon Grodzins. *Phys. Rev.* 84, 582-4(1951) Nov. 1. (Letter to the editor)  
Penetrating showers produced in Be by cosmic radiation have been investigated with cloud-chamber equipment. The showers produced in two Be plates within the cloud chamber are discussed with respect to multiplicity and angular distributions. The average multiplicity per shower in the space below the origin of production is about 2.5, and shower particles are emitted with an extremely strong preference for the direction of the primary. The mean free paths in Pb of shower particles produced in the first and second Be plates are 180 g/cm<sup>2</sup> and 200 g/cm<sup>2</sup>, respectively.
- 266  
PENETRATING SHOWERS PRODUCED IN CARBON AND LEAD AT SEA LEVEL. W. Y. Chang and G. del Castillo. *Phys. Rev.* 84, 584-5(1951) Nov. 1. (Letter to the editor)  
Penetrating showers produced in C and Pb by cosmic radiation have been investigated with cloud-chamber equipment. The average multiplicity per shower is 2.8 for both C and Pb. The mean free paths in Pb of shower particles produced in C and in Pb are 45 g/cm<sup>2</sup> and 40 g/cm<sup>2</sup>, respectively. The angular distributions show extremely strong preference for the forward direction of the primary particle.
- 267  
MULTIPLE EVENTS PRODUCED IN HYDROGEN BY VERY HIGH ENERGY COSMIC-RAY PARTICLES AT AN ALTITUDE OF 90,000 FEET. M. L. Vidale and Marcel Schein. *Phys. Rev.* 84, 593-4(1951) Nov. 1. (Letter to the editor)  
A counter experiment has been performed at an altitude of 90,000 ft to study the production of mesons in the interactions of cosmic-ray particles with hydrogen nuclei. The proton target consisted of a spherical metal Dewar filled with liquid H<sub>2</sub>. It is concluded from the frequency and angular distribution of multiple events that primary protons of energy 50 to 100 bev interact in H<sub>2</sub> with a cross section equal to 1 to 2 times the geometrical cross section of a single proton, producing on the average 4 or more charged mesons. Multiple meson production in H<sub>2</sub> must have a very low probability for nucleon energies <10 bev.
- 268  
THE SEA-LEVEL LATITUDE VARIATION OF FAST COSMIC-RAY NEUTRONS. P. S. Gill and L. F. Curtiss. *Phys. Rev.* 84, 591-2(1951) Nov. 1. (Letter to the editor)  
By means of B<sup>10</sup>-enriched BF<sub>3</sub> proportional counters embedded in a paraffin block, the intensity of fast neutrons generated in the atmosphere by cosmic rays has been measured as a function of latitude. Measurements were made in India in a narrow range of longitudes at geomagnetic latitudes 3°4', 11°9', and 18°12' N, respectively. Results in neutron cpm were as follows:  $1.57 \pm 0.04$ ,  $1.49 \pm 0.02$ , and  $2.08 \pm 0.03$  in order of increasing latitude.
- 269  
THE MOMENTUM SPECTRUM OF COSMIC-RAY PROTONS. C. B. A. McCusker and H. Messel. *Proc. Phys. Soc. (London)* 64A, 948-9(1951) Oct. (Letter to the editor)  
Recently the momentum spectrum of cosmic-ray protons has been measured both at the top of the atmosphere and at sea level. In his theory of the nucleon cascade Messel (NSA-5-5997) has used a value for the exponent of the differential spectrum of -2.1 and has obtained good agreement with a wide range of experimental data. This, however, predicts that an incident power law should be reproduced throughout the atmosphere for all energies above the cutoff if ionization loss is neglected. It is shown that in the range  $10^3$  to  $10^4$  Mev the points are well fitted by a power law of exponent -2.0 when ionization losses are included.
- 270  
THE DENSITY OF THE PENETRATING PARTICLES IN EXTENSIVE COSMIC-RAY AIR SHOWERS. C. B. A. McCusker and D. D. Millar. *Proc. Phys. Soc. (London)* 64A, 915-20(1951) Oct.  
The ratio of penetrating particles to electrons in extensive cosmic-ray showers has been investigated experimentally at sea level. For the great majority of showers this ratio, in agreement with previous results, is found to be 2.5%. A small number of showers were detected in which the proportion of penetrating particles was much greater.



## ELECTRICAL DISCHARGE

271

Atomic Energy Research Establishment, Harwell, Berks (England)

THE EFFECT OF SURFACE TREATMENT ON ELECTRIC BREAKDOWN BETWEEN COPPER ELECTRODES AT 50 CYCLES AT VERY LOW PRESSURES; by R. J. B. Hadden. Aug. 1951. 14p. (AERE-G/M-92)

The preparation of pure-copper electrode surfaces by electrolytic polishing is described. It is shown that this surface treatment does not affect the electrical breakdown between the copper electrodes at pressures of  $10^{-5}$  to  $10^{-6}$  mm Hg.

## GASES

272

Oak Ridge National Lab., Y-12 Area

CONTAINMENT OF HELIUM IN STAINLESS STEEL AND INCONEL AT THE 1500°F+ RANGE; by E. Wischhusen. Oct. 16, 1951. 11p. (ANP-72)

He permeation through seamless type-316 stainless-steel and inconel tubing of 0.030-in. wall thickness has been investigated. The He was pressured into the annular space between the outer wall of the tubing to be tested and the inner wall of the "IPS" jacket. Modified Swagelok tubing-to-pipe male connectors were used to seal the jacket to the tubing. The jacketed tubes were put into an electric furnace and maintained at 1600°F for 150 hr, the He being under 54 psi static pressure differential. A He leak detector capable of detecting one part He in  $3.2 \times 10^6$  failed to find any He within the tested tubing.

273

Battelle Memorial Inst.

EXPLOSION LIMITS OF THE HYDROGEN-OXYGEN-WATER SYSTEM AT ELEVATED TEMPERATURES; by H. A. Pray, C. E. Schweickert, and E. F. Stephan. Nov. 1, 1951. 28p. (BMI-705)

The design and operation of equipment containing mixtures of  $H_2$ ,  $O_2$ , and water vapor must take into consideration the potential hazards involved. Data are given on the theoretical pressures due to the reaction in saturated water vapor of stoichiometric mixtures of  $H_2$  and  $O_2$  at partial pressures up to 100 psia and initial temperatures up to 650°F. By allowing for the effects of violent explosive reactions, these data are translated into design pressures. The explosive limits of various mixtures of  $H_2$  and  $O_2$  at partial pressures from 10 to 200 psia in saturated water vapor from room temperature to 600°F were determined experimentally. Mixtures with partial pressures of  $H_2$ - $O_2$  greater than 27% of the total pressure were reactive under all conditions tested; whereas, with less than 17%, no mixtures were reactive. No evidence of autoignition or spontaneous combustion occurred under any of the conditions studied. (auth)

274

Central Air Documents Office

THERMODYNAMIC FUNCTIONS OF HALOGENS AND HYDROGEN HALIDES; by Rudolph Edse. Nov. 1949. 51p. (F-TR-2250-IA; ATI-43532)

275

Ames Lab.

VAPOR PRESSURE OF ZIRCONIUM TETRACHLORIDE BY MOLECULAR EFFUSION; by James M. Scarborough and Wm. K. Plucknett. Dec. 1950. 31p. (ISC-92)

Briefly, the methods of determining low vapor pressures have been reviewed. Emphasis has been placed on molecular effusion, including the application of molecular beams to the determination of vapor pressure. The problems met in the preparation, purification and handling of anhydrous

zirconium tetrachloride have been discussed. Vapor pressure measurements on zirconium tetrachloride have been made over a temperature range of 70 to 120°C, and the mean molar heat of sublimation for this temperature range has been calculated. The value of 20.3 kcal/mole obtained is not unreasonable in view of the fact that values for the same quantity determined by other investigators in the temperature range of 239 to 346°C is reported to be 24.4 kcal/mole. (auth)

## INSTRUMENTS

276

Ames Lab.

HIGH TEMPERATURE THERMOCOUPLES; by H. A. Wilhelm, H. J. Svec, A. I. Snow, and A. H. Daane. Issued June 29, 1948. Decl. Nov. 19, 1951. 6p. (AECD-3275; ISC-22)

In a search for an accurate means of measuring temperatures up to 2000°C, calibration curves for Mo-W, Ta-W, and Nb-W thermocouples were prepared. The Nb-W thermocouple proved best for the purpose. Junctions could not be welded since the W became brittle in the process, but by tightly twisting Nb wire around the W for several millimeters and tightly pinching the two together a satisfactory junction was obtained.

277

Oak Ridge National Lab.

INSTRUMENT RESEARCH AND DEVELOPMENT  
QUARTERLY PROGRESS REPORT FOR PERIOD ENDING  
APRIL 20, 1951; W. E. Thompson, comp. Nov. 2, 1951. 29p. (ORNL-1056)

The described  $4\pi$  proportional  $\beta$  counter for obtaining disintegration rates requires a minimum amount of information about the decay scheme and does not have the disadvantage of the coincidence method in that it can be applied to pure  $\beta$  emitters. A precision pulser circuit is given as a modification of that in report ORNL-788. The constant water monitor described consists of a continuous-flow water cell of 4 liters/min capacity, a 40-kev  $\beta$ -sensitive G-M counter, lead shielding, and control panel. The normal background count rate is about 7 cpm, and water of about  $2 \times 10^{-6}$   $\mu\text{C}/\text{ml}$  of  $\text{Sr}^{90}$  activity is detectable by an approximately 50% increase of the background counting rate.

278

Radiation Lab., Univ. of Calif.

SUMMARY OF RESEARCH PROGRESS MEETING OF  
JULY 26, 1951; by Bonnie E. Cushman. Oct. 19, 1951. 4p. (UCRL-1501)

The heat exchanger of the 184-in. cyclotron magnet was cleaned by use of a mixture of kerosene and other light gasoline fractions. This reduced the temperature from above the 55°C safety limit to less than 45°C. The current problem in development of a photocathode tube is the obtaining of a uniform activation of the photosensitive surface; Cs does not deposit itself uniformly over the Sb. A linear tube is described which has a peak output current of 1 amp at 0.5 kv and 14 electron multiplier stages which give an amplification of  $10^9$ . The nonproportionality of present photomultiplier tubes was also discussed.

279

PRODUCTION OF HIGH SPECIFIC ACTIVITIES WITH A  
22-Mev BETATRON. Robert A. Becker. *Rev. Sci. Instruments* 22, 773-6(1951) Oct.

An internal probe technique of producing strong gamma- $\gamma$  and gamma- $\beta$  activities with a betatron is described. Sources approaching 1 mc in strength of  $\text{Cu}^{62}$  have been realized. A typical specific activity of  $\text{Cu}^{62}$  produced in a piece of half-mil copper 2 mm by 24 mm is 7 mc/g. (auth)

280

ON THE THEORY OF THE ELECTROSTATIC BETA-PARTICLE ANALYZER. V. F. T. Rogers, Jr. Rev. Sci. Instruments **22**, 723-6(1951) Oct.

Focusing properties of the inverse-radial potential in the spherical electrostatic analyzer for charged particles having relativistic speeds are calculated by a first-order method valid for large values of  $\beta = v/c$ . Extending similar calculations of focusing by the logarithmic potential in the cylindrical analyzer, the treatment stresses deviations from focusing properties for low speed particles, and emphasizes analogies between the characteristics of focusing accomplished by each type of field, wherever possible. Approximate formulas are given by which the diameter of the region of least confusion may be computed for several interesting situations. (auth)

281

ON THE POSSIBILITY OF CORRECTING THE MAGNETIC LENSES USED IN  $\beta$ -RAY SPECTROMETRY. Pierre Hubert. Compt. rend. **233**, 943-5(1951) Oct. 22. (In French)

Annular focusing correction of a small magnetic electron lens may be achieved by placing a diverging air-core coil on the axis of symmetry at the center of the field. The apparatus is sketched, the correction obtained is shown graphically, and extension to large  $\beta$ -ray spectrometers is discussed.

282

A SIMPLE ELECTROMETER FOR MODERATELY SMALL CURRENTS. R. M. Dowben. In Forsvarets Forsknings-institut Årbok III, 1950-1951, p. 141-3.

A simple, direct-reading electrometer is described for use in the current range  $10^{-8}$  to  $10^{-14}$  amp. Random zero variation and drift are low.

283

ON THE THEORY OF THE TRANSGAUSSIAN REGION OF THE ELLIPTICAL ELECTROSTATIC LENS. Édouard Regenstein. Compt. rend. **233**, 854-6(1951) Oct. 15. (In French)

Equations for electron trajectories in strongly and weakly elliptic fields are derived by an extension of the first-order theory previously established (Regenstein, Compt. rend. **232**, 1818(1951)) to the transgaussian domain (*ibid.*, **230**, 1650(1950)).

## ISOTOPES

284

Radiation Lab., Univ. of Calif.

THE PRODUCTION AND ASSIGNMENT OF  $\text{Ra}^{230}$  AND  $\text{Ac}^{230}$  (abstract); by William A. Jenkins and Glenn T. Seaborg. Oct. 19, 1951. 1p. (UCRL-1512)

The report is reproduced here in its entirety.

The bombardment of thorium metal with 180-Mev deuterons in the 184-in. cyclotron, followed by extensive chemistry, has demonstrated the presence of a new isotope of radium. This isotope proved to decay by beta-particle emission with a half life of 1 hr and is best assigned to  $\text{Ra}^{230}$ . Attempts to milk the actinium daughter were unsuccessful and consequently the upper limit of the actinium half life is set at 1 min. The beta-particle energies were measured by Feather analysis of aluminum absorption curves and by Fermi analysis of a beta-particle spectrograph plot which indicated two beta distributions with maxima at 2.2 and 1.2 Mev. From the disintegration energies predicted by closed decay energy cycles, it seems most probable that the 1.2-Mev beta is associated with the 1-hr decay of  $\text{Ra}^{230}$  and the 2.2-Mev beta, with  $\text{Ac}^{230}$ . This assignment was strengthened by the recent discovery by B. G. Harvey and coworkers (private communication (Sept. 1951)) of a 67-min activity which they assigned to  $\text{Ac}^{229}$ . This half life of  $\text{Ac}^{229}$  has been recently confirmed by the reaction  $\text{Ra}^{226}(\alpha, p)\text{Ac}^{229}$  in this laboratory.

285

Oak Ridge National Lab., Y-12 Area

ELECTROMAGNETICALLY ENRICHED ISOTOPES (Inventory, Sept. 30, 1951); by C. P. Keim, C. E. Normand, and Boyd Weaver. Sept. 30, 1951. 71p. (Y-819)

This inventory lists the isotopes which have been concentrated electromagnetically, along with the completed information on their enriched abundances, and the element weights and product forms available in milligram quantities to users on Atomic Energy Commission projects and in university and industrial laboratories. (auth)

## ISOTOPE SEPARATION

286

Naval Research Lab., Univ. of Wisconsin

THE SEPARATION OF ISOTOPIC MIXTURES BY MEANS OF ULTRASONIC RADIATION; SUMMARY REPORT; by Charles A. Boyd, Joseph O. Hirschfelder, and Charles F. Curtiss. Jan. 3, 1951. 37p. (NP-3486)

Section 1 summarizes a literature survey and presents all of the known treatments of the effect of sound on mixtures. Section 2 presents the theoretical treatment of isotope separations by ultrasonic radiation. Section 3 reports the verification here of experiments which have been discussed in the literature and have been described as producing separation. In the case of separation in liquid solutions it was found that the effects were due to thermal diffusion rather than ultrasonic separation, and this is also apparently true in the case of gas diffusion. Additional experimental work, coupling ultrasonics with the electrolytic separation of hydrogen and deuterium, was found to decrease the separation factor rather than increase it.

287

THE SEPARATION OF ISOTOPES AND THEIR APPLICATION TO RESEARCH. Klaus Clusius. Verhandl. schweiz. naturforsch. Ges. **130**, 33-52(1950). (In German)

A general description of several methods for separating stable isotopes, a brief discussion of the production of radioisotopes by fission, and some generalities on isotope applications are presented. No references.

## MASS SPECTROGRAPHY

288

Columbia Univ.

METHOD OF CALCULATION OF FEED BACK; METHOD OF ANALYSIS FOR  $\text{C616} [\text{UF}_6]$  COMPOSITION; by M. G. Inghram, B. M. Rustad, and M. Fox. Dec. 29, 1944. Decl. Nov. 13, 1951. 17p. (AECD-3271; A-2185)

This report is a summary of the methods of calculation used to compute the separation of U isotopes in  $\text{UF}_6$  when measured on the mass spectrometer. The report is divided into two sections. One deals with the manual operation of the mass spectrometer in which the readings are taken manually from a galvanometer. The second deals with the operation of the automatic recording spectrometer in which the readings are recorded on a recording potentiometer. The two methods of calculation are entirely different due to the fact that the electronic measuring devices are distinct in the two cases. No attempt is made to be completely rigorous, but all important approximations made in the proofs are stated, so that a satisfactory equation for operation in any range of concentration of  $\text{U}^{234}$ ,  $\text{U}^{235}$ , and  $\text{U}^{238}$  can be derived. (auth)

289

Radiation Lab., Univ. of Calif.

DESIGN AND OPERATION OF A HIGH GEOMETRY ELECTROSTATIC TIME-OF-FLIGHT MASS SPECTROGRAPH (abstract); by William E. Glenn. Oct. 19, 1951. 1p. (UCRL-1511)



The report is reproduced here in its entirety.

A mass spectrograph has been designed and constructed which measures  $e/m$  by measuring the time of flight of ions that have been accelerated and bunched by electrostatic fields. This instrument is similar to the Smyth and Wilson "Isotron." It has been able to collect about 30% of the ions formed of a given isotope. The resolution is such that the width of the intensity vs. mass peaks is  $\frac{3}{4}$  of a mass unit wide at 1% of the maximum intensity for all masses. The stability and linearity of the mass calibration is accurate to less than  $\frac{1}{10}$  of a mass unit. Experimental determinations of the geometry, resolution, and calibration were made with Rb, Cs, and Tl. Methods of detection include the use of an electron multiplier and vibrating-reed electrometer. Methods of eliminating the direct, neutral beam, and ions of the wrong transit time have been devised. The instrument can be used for the isolation of individual artificially produced radioactive isotopes, and some preliminary experiments of this type have been performed.

290

THERMAL ION SOURCES FOR NEGATIVE IONS. Heinrich Hintenberger. *Helv. Phys. Acta* 24, No. 4, 307-9(1951) Sept. 20. (In German)

Two ion sources, one with directly heated filament for solid and gaseous substances, and one for indirectly heating compressed metal powders, are sketched and discussed.

291

DETERMINATION OF IONIZATION POTENTIALS BY MASS SPECTROGRAPHY. G. Nief. *J. chim. phys.* 48, 333-5 (1951) July-Aug. (In French)

The mass spectrometer may be used to determine ionization potentials by adjusting the apparatus to the mass of the singly ionized molecule, then decreasing the electron-accelerating voltage to disappearance of the mass peak. The electron voltage then equals the ionization potential. Difficulties encountered in practice are discussed, and experimental values are given for  $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{C}_6\text{H}_5\text{CH}_3$ ,  $\text{C}_2\text{H}_5\text{OH}$ , and  $\text{NO}$ .

## MATHEMATICS

292

Brookhaven National Lab.  
REMARKS CONCERNING THE EXISTENCE OF THE FOLDY-WOUTHUYSEN TRANSFORMATION; by Hartland S. Snyder. Oct. 2, 1951. 2p. (BNL-1002)

The report is reproduced here in its entirety.

Foldy and Wouthuysen (Phys. Rev. 78, 29(1950)) have shown for a free Dirac particle that there exists a unitary transformation which removes all odd operators from the hamiltonian. In the case where there is an electromagnetic field present such a transformation was not found explicitly, and a power series expansion in inverse powers of the particle mass was given for the unitary transformation and for the transformed hamiltonian. These authors raised questions concerning the convergence of these series but did not answer them. It is the purpose in this note to show that a transformation of the Foldy-Wouthuysen type does not in general exist and thus in some circumstances these power series cannot converge. This is done by showing that the existence of the Foldy-Wouthuysen transformation is incompatible with known properties of the solution of Dirac's equation in the presence of external electromagnetic fields. To do this we consider the case where the electromagnetic field is present only in a finite portion of space time. If we consider any solution of the Dirac equation which has only positive (negative) frequency parts at times before there was any electromagnetic field present then at times after the electromagnetic field has disappeared the solution will have both

positive and negative frequency parts. If the Foldy-Wouthuysen transformation exists, the original Dirac equation is decomposed into two sets of uncoupled two-component equations. For times earlier or later than the region in which the electromagnetic field is present this transformation ensures that one of these two sets of equations corresponds to positive, the other to negative frequency solutions of Dirac's equation. Since these two sets of equations are uncoupled, a solution of Dirac's equation which contains only positive (negative) frequency components before the time of interaction would contain only positive (negative) frequency components after the time of interaction. This is not true and one may therefore conclude that the Foldy-Wouthuysen transformation does not exist under circumstances where pair production by an external field is possible. This does not, of course, mean that a few terms of the power series of Foldy-Wouthuysen are not useful and valid for the description of the nonrelativistic aspects of the Dirac equation.

## MEASURING INSTRUMENTS AND TECHNIQUES

293

Oak Ridge National Lab. and Tennessee Univ.  
A METHOD FOR ALPHA RADIATION DOSIMETRY IN SINGLE CELLS (abstract); by R. W. Rogers. 1p. (AECU-1707)

The report is reproduced here in its entirety.

A modification of the well-known scintillation counting technique for alpha particles is suggested for measuring alpha radiation dose rates in biological materials, particularly single cells. Both dose rate and "field intensity" variations can be measured with some accuracy. A single zinc sulfide crystal comprised the scintillation screen, rather than the many crystals typically used. Crystal size may be selected to compare with the cell dimension and ranges from a few to 50 or more microns. Observations are made with binocular microscope at magnification of  $100\times$ . Scintillations may be readily counted in crystals of only  $5\ \mu$  diam, under properly dark-adapted conditions. Consistent agreement between theoretical and empirical data regarding probability distribution of alpha particles is obtained at ranges of 1 cm or greater; marked disparity is observed at ranges of only 1 or 2 mm. (auth)

294

Los Alamos Scientific Lab.  
RADIATION COUNTING BY SCINTILLATION METHODS; by F. Newton Hayes. [nd] 9p. (AECU-1710; LADC-1042)

The use of scintillator solutions, in which is dissolved biological material for homogeneous counting as a means of improving efficiency in counting low-energy-level radiation, is discussed. It is pointed out that with the use of the proper scintillator solutions and the proper adjustment of light reflection and transmission, 100% counting efficiency should be approached, compared with 10 to 50% efficiency using the best solid-sample counters now available. The mode of action of organic scintillator solutions is discussed. Problems are discussed which might arise in counting biological material where  $\text{Ca}^{45}$ ,  $\text{C}^{14}$ , tritium, and  $\text{S}^{35}$ , all of which are low-energy  $\beta$  sources, are used as tracers. The synthesis and characterization of compounds which are suitable for use as solvents and possible scintillators are discussed in detail.

295

National Bureau of Standards  
ANNUAL REPORT ON RADIATION SENSITIVITY OF PHOTOGRAPHIC EMULSIONS; COVERING THE FISCAL YEAR JULY 1, 1950, TO JULY 1, 1951; by Margarete Ehrlich. [nd] 5p. (NBS-1146)

Brief notes are made of the temperature dependence of fading and fogging for various emulsions, the influence of

film agitation during development upon the absolute film density level and the uniformity of film density, the effect of photographic reversal as a source of error in photographic dosimetry, and the calibration of various emulsions in the range 0.08 to 1 Mev.

296

Lab. for Nuclear Science and Engineering and Servomechanisms Lab. Mass Inst. of Tech.  
PERIODIC STATUS REPORT NO. 8; [PERIOD JULY 1, 1949, TO OCTOBER 1, 1949; NEUTRON AND GAMMA RAY SHIELDING GROUP AND ELECTRONIC NUCLEAR INSTRUMENTATION GROUP]. Oct. 1, 1949. 18p. (NP-3173)

Gamma ray absorption vs. distance measurements in moist sand indicate that the measured intensity deviates from the value predicted by the simple exponential theory and even has a peak at  $\sim 10$  cm. Brief notes are presented on the development or modification of the following pieces of equipment: the accelerating tubes for the Rockefeller generator, a proton resonance magnet control system for the Van de Graaff generator, a fission chamber for monitoring the neutron beam intensity of the Van de Graaff generator for neutron energies above 1 Mev; a long counter assembly of BF<sub>3</sub> tube and paraffin cylinder, a methane proportional counter, high-voltage power supplies, and coincidence circuits. A pulse-height distribution curve was obtained using a spherical ionization chamber for the pulses produced by the 5.3-Mev  $\alpha$  particles resulting from the decay of Po<sup>210</sup>. Increasing the argon pressure from 4 to 50 psi increased the sharpness of the distribution curve.

297

Radiation Lab., Univ. of Calif.  
A FAST MULTIPLE CHANNEL COINCIDENCE AND ANTI-COINCIDENCE CIRCUIT; by Leroy Kerth and Howard A. Wilcox. Oct. 8, 1951. 9p. (UCRL-1499)

A multiple channel coincidence circuit is described whose resolving time is about  $10^{-8}$  sec. This circuit is suitable for use with arrays of scintillator-photomultiplier tube counters to detect subatomic particles. The input channels can be transformed into anticoincidence channels by a simple switching operation. Details of construction are given. (auth)

298

Radiation Lab., Univ. of Calif.  
PHYSICAL MEASUREMENTS ON NUCLEAR PHOTOGRAPHIC EMULSION (abstract); by A. J. Oliver and Walter H. Barkas. Oct. 24, 1951. 1p. (UCRL-1528)

The report is reproduced here in its entirety.  
Calculations of the stopping power of nuclear photographic emulsion and of the volume of emulsion at the time of exposure may be made with more accuracy if the dependence of density and thickness upon relative humidity were known in more detail than is available in published specifications. A device has been developed for measuring the expansion of emulsion with measured increases of relative humidity, both for unprocessed and for processed plates. The measurement of thickness without distorting soft emulsion at relative humidities from 10 to 90% was the primary contribution of this work. A second project was the measurement of average thickness and weight for the derivation of a density vs. relative humidity relationship. A third measurement was a check of the refractive indices of emulsion and of the immersion oil employed, so that depth measurements with the microscope are calibrated properly. Measured shrinkage factors were found to vary between 1.8 and 3, depending on humidity conditions. The emulsion measured was Ilford Type C-2, and the processing included fixing and hardening in Kodak Acid Fixer.

A chart has been worked out to be employed in determining thickness at exposure, giving final thickness and the relative humidities before and after processing.

299

Radiation Lab., Univ. of Calif.  
A NEW TYPE CERENKOV COUNTER (abstract); by Robert W. Birge. Oct. 31, 1951. 1p. (UCRL-1544)

The report is reproduced here in its entirety.

A new type Cherenkov counter has been built that uses ideas similar to those suggested by I. A. Getting (*Phys. Rev.* **71**, 123 (1947)). In our counter the center portion is cut out to reduce the amount of light due to scintillations. Previous tests of Getting's counter by R. H. Dicke (*Phys. Rev.* **71**, 737 (1947)) were not conclusive, mainly because of the lack of a fast coincidence circuit to eliminate phototube noise. However, the recent experiments by John Marshall (*Phys. Rev.* **81**, 275 (1951)) indicate that a Cherenkov counter can be made to work. The counter to be described was tested in coincidence with a stilbene crystal using a circuit with a resolving time of about  $10^{-9}$  sec, developed by Lee Neher at the Radiation Laboratory. Transition curves were taken using the gamma rays from  $\pi_0$ -meson decay in the target of the 184-in. cyclotron. Evidence will be given to show that Cherenkov radiation from the resulting electrons can be detected with reasonable efficiency.

300

A DETERMINATION OF THE ELECTRICAL DEPTH OF AN IONIZATION CHAMBER. G. P. Brouwer and H. W. Horeman. *Physica* **17**, 821-9(1951) Sept.

The electric field in the neighborhood of the entrance aperture of an ionization chamber has been investigated by the method of the electrolytical trough. The electrical boundary, which is the plane where the axial field strength is zero, is determined for various geometrical configurations. The results prove that the divergence of the electrical boundary from the geometrical boundary may easily rise to an appreciable value, so that in accurate ionization measurements appropriate corrections for this divergence must be applied. (auth)

301

ON A CADMIUM IODIDE SCREEN FLUORESCENT UNDER THE ACTION OF VISIBLE, ULTRAVIOLET, CATHODE,  $\alpha$ , AND X RADIATIONS. Sreten Schlivitch. *Compt. rend.* **233**, 1023-4(1951) Oct. 29. (In French)

A mixture of Pb(NO<sub>3</sub>)<sub>2</sub> and CdI<sub>2</sub> of wide permissible proportions, pulverized together and deposited on glass from H<sub>2</sub>O or acetone, gives a fluorescent screen of brightness equal to uranyl salts and with a spectrum between 4700 and 6500 Å, the region to which the eye is most sensitive. Effects of specific radiations and temperature effects are discussed briefly.

302

A STUDY OF SCINTILLATIONS OF ALKALI HALIDES. J. Bonanomi and J. Rossel. *Helv. Phys. Acta* **24**, No. 4, 310-15(1951) Sept. 20. (In French)

The scintillations per second as a function of temperature (glow curves) and the decay of luminescence following irradiation by the 1.2-Mev  $\gamma$  ray of Co<sup>60</sup> have been measured for pure LiI, NaI, and KI, and for Tl-activated NaI and KI. The temperatures at which measurements were made fall in the range 0 to  $-180^\circ\text{C}$ . Constants for the luminescence-decay law have been calculated for each case, and the nature of the luminescent centers of the pure crystals is discussed briefly.

303

THE COUNTING OF RANDOM PULSES. E. H. Cooke-Yarborough. *J. Brit. Inst. Radio Engrs.* **11**, 367-80(1951) Sept.



Various electronic and electromechanical means for counting pulses are considered; particular reference is made to the means of counting randomly spaced pulses. Various means of measuring the mean rate of occurrence of random pulses are described, in particular, means for measuring the duration of the counting period and automatically terminating the count at an appropriate point. No detailed circuit descriptions are given, but there are numerous references to published circuits.

304

PHYSICAL MEASUREMENTS ON VARIOUS BETA-RAY APPLICATORS. Jack S. Krohmer. Am. J. Roentgenol. Radium Therapy **66**, 791-6(1951) November.

The results of ionization measurements on various beta-ray applicators are presented. A comparison of the applicators is made based upon these measurements and other physical factors. Depth dose curves are shown for each applicator. The result of a biological comparison of experimental applicators and a superficial x-ray unit is included. (auth)

305

RADIOACTIVITY, MEASUREMENT AND APPLICATIONS. J. Halberstadt. Chem. Weekblad **47**, 701-7(1951) Sept. 22. (In Dutch)

A brief general discussion of radioactivity-detecting apparatus, corrections applied in measurements, and a few physical, chemical, and industrial applications of radioisotopes is presented.

306

THE SPECIFIC FLUORESCENCE OF ANTHRACENE AND OTHER ORGANIC MATERIALS. J. B. Birks. Phys. Rev. **84**, 364-5(1951) Oct. 15. (Letter to the editor)

The variation of the specific fluorescence  $dS/dr$  with specific energy loss  $dE/dr$  is explained in terms of the exciton theory. If the number of excitons produced per unit path length is  $A dE/dr$ , the local concentration of damaged molecules is  $B dE/dr$  molecules per undamaged molecule, and if the exciton capture probability of a damaged molecule relative to an undamaged one is  $k$ , then  $dS/dr = (A dE/dr)/(1 + kB dE/dr)$ . The values for anthracene of  $A = 82.5$ ,  $kB = 7.15$  have been calculated from observations (Birks, Proc. Phys. Soc. (London) **63A**, 1294 (1950)) on  $\alpha$  particles and electrons. The variation of  $dS/dr$  with  $dE/dr$  is plotted. The curve is in excellent agreement with the experimental curve of Jentschke et al. (Phys. Rev. **82**, 170(1951)). Calculated curves of scintillation response of anthracene to  $\alpha$  particles, deuterons, protons, and electrons are also in excellent agreement with experimental curves. The behavior of other organic crystals is similar.

307

ELECTRON AND GAMMA RAY SPECTROSCOPY WITH SCINTILLATION DETECTORS. R. C. Bannerman, G. M. Lewis, and S. C. Curran. Phil. Mag. (7) **42**, 1097-1112 (1951) Oct.

An account is given of  $\beta$ - and  $\gamma$ -ray energy measurements with anthracene and NaI(Tl) single crystals. Various coincidence techniques appropriate to scintillation detectors are examined experimentally, and an investigation is made of the application of a single crystal, with source buried inside, to the elucidation and closer examination of decay schemes. Work is described on standard sources, on  $Hg^{203}$ , and in some detail on  $La^{140}$ . New information is given for  $La^{140}$  concerning the 0.093  $\gamma$  ray, the high-energy  $\gamma$  ray, and the decay scheme. (auth)

308

ON LOADING NUCLEAR EMULSIONS WITH WIRES.

M. Danyasz and G. Yekutieli. Phil. Mag. (7) **42**, 1185-6(1951) Oct. (Correspondence)

A method of loading nuclear emulsions with wires has been developed. Nylon threads and Cu wires of thickness 25, 40, and 60  $\mu$  have been used. For materials which react with the emulsion, satisfactory protection of the emulsion is given by coating the wires with a thin layer of enamel. Methods are discussed for elimination of the distortion introduced by the differential shrinkage of emulsion and wires.

309

PROPORTIONAL COUNTER FOR INVESTIGATION OF SOFT  $\beta$  AND X RADIATION. Gudbrand Jenssen. In Forsvarets Forskningsinstitut Årbok III, 1950-1951, p.133-9. (In Norwegian)

An argon-filled proportional counter which has been used to study  $\beta$  radiation below 50 kev energy and x radiation below 28.5 kev is sketched, and curves indicating its resolving power are given. 6 figures.

310

SLOW DISCHARGE IN A NON-SELF-QUENCHING GEIGER-MUELLER COUNTER. W. E. Ramsey. J. Franklin Inst. **252**, 143-51(1951) Aug.

The slow discharge process in a nonself-quenching G-M counter is made up of one of more self-terminating active periods marked by photon emission and ionization by collision.

311

INFLUENCE OF QUANTA ON THE PHOTOGRAPHIC EFFECT OF X-RAYS AS A FUNCTION OF WAVE LENGTH AND OF SENSITIZATION. Hermann Hoerlin. Z. Naturforsch. **6a**, 344-9(1951) July. (In German)

A study of the photographic effect of x-rays on two highly sensitive emulsions in the wave range of 1.3 to 0.01  $\text{\AA}$  shows that the number of AgBr grains exposed to an absorbed quantum increases with the energy of the photo and recoil electrons, while in the short-wave range not all gains are developed. Sensitization of x-ray emulsions with complex salts causes an increase of sensitivity which is strongly dependent on wavelength. Data are graphed and tabulated. 24 references.

312

THE DISSOCIATION OF ETHYL-ACETATE IN GEIGER-MÜLLER COUNTER. Stephen S. Friedland and Henry S. Katzenstein. Phys. Rev. **84**, 591(1951) Nov. 1. (Letter to the editor)

A G-M counter filled with argon only was run as a non-selfquenching counter for at least  $10^{10}$  counts, and its contents were then studied with a mass spectrometer. The only peak was mass 40 for argon. This is interpreted as proof that the mass 44 observed in a similar experiment (Friedland, Phys. Rev. **74**, 898(1948)) with ethyl acetate and argon in a G-M counter was due to dissociation of the ethyl acetate.

313

THE DESIGN OF PORTABLE GAMMA- AND BETA-RADIATION MEASURING INSTRUMENTS. E. Franklin and J. Hardwick. J. Brit. Inst. Radio Engrs. **11**, 417-34 (1951) Oct.

The principal considerations which enter into the design of portable  $\gamma$ - and  $\beta$ -radiation measuring instruments, both ionization chamber and G-M types, are described. The methods which have been used and are now being investigated to achieve optimum performance with high reliability are discussed. The problems introduced by the use of cold-cathode tubes are discussed.

314

CALCULATION OF COUNTING LOSSES IN SCALERS BY THE THEORY OF JOST. E. Baldinger and K. Halbach. Helv. Phys. Acta **24**, No. 4, 315-17(1951) Sept. 20. (In German)

Counting losses in several scaling circuits having finite resolving time are treated by the method of Jost (Helv.

Phys. Acta 20, 173(1947)). The exact calculation by this method is not considered more difficult or longer than by the method of Elmore (Nucleonics 6, 26(1950)).

## MESONS

315

Brookhaven National Lab.

SCATTERING OF  $\pi$ -MESONS BY HYDROGEN AND HELIUM (abstract); by A. M. Thorndike, E. C. Fowler, R. P. Shutt, and W. B. Fowler. [nd] 1p. (BNL-1011)

The report is reproduced here in its entirety.

$\pi$ -Mesons from the Nevis cyclotron have been observed to undergo nuclear scattering in the gas of a diffusion cloud chamber.  $\pi$ - $\mu$  decays occurring in flight are also seen and their number determines the meson path length recorded. Data analyzed so far provide the following results: (A) 60-Mev  $\pi^-$  mesons in hydrogen experienced only three scatterings in a path length of 1700 g/cm<sup>2</sup>. (B) 40-Mev  $\pi^+$ -mesons in helium experienced 7 scatterings in a path length of 460 g/cm<sup>2</sup>. Comparison of (A) with the 125 g/cm<sup>2</sup> of Steinberger et al. (Chedester, Isaacs, Sachs, and Steinberger, Phys. Rev. 82, 958 (1951)) at 85 Mev indicates a rapid increase in cross section with increasing energy as expected for derivative meson couplings (Ashkin, Simon, and Marshak, Progress Theoret. Phys. 5, 634 (1950)). (B), on the other hand, gives a cross section comparable with "geometrical," as observed for larger nuclei.

316

Brookhaven National Lab.

$\pi^-$  - p SCATTERING OBSERVED IN A DIFFUSION CLOUD CHAMBER; by R. P. Shutt, E. C. Fowler, D. H. Miller, A. M. Thorndike, and W. B. Fowler. [nd] 4p. (BNL-1017)

Scattering of 60-Mev negative pions has been observed in a high-pressure diffusion cloud chamber operated in a pion beam at the Nevis cyclotron. In 5600 pictures only three cases were observed which can be considered to be  $\pi^-$  - p scatterings. The scattering angles of the three events, measured from the direction of the incident pion, are: pion 54° and recoil proton 57°, pion 70° and proton 44°, pion leaves illuminated region and proton 35°. These data give a cross section of 3 mb for scattering of 60-Mev negative pions by hydrogen. A diagram of the diffusion chamber and a photograph of one scattering event are shown.

317

Radiation Lab., Univ. of Calif.

FURTHER RESULTS ON THE PRODUCTION OF NEUTRAL MESONS BY PHOTONS; by Wolfgang K. H. Panofsky, Jack Steinberger, and Jack Steller. Oct. 1, 1951. 41p. (UCRL-1495)

New data have been obtained on production of  $\pi^0$  mesons in Be irradiated in the 325-Mev x-ray beam of the Berkeley synchrotron. Conversion electrons of the  $\gamma$  rays from  $\pi^0$  decay were detected in coincidence to determine  $\gamma$ - $\gamma$  correlation curves. The Z dependence of production was studied by measuring  $\gamma$ - $\gamma$  coincidences with targets of Li, Be, C, Al, Cu, Pb, and H. Preliminary data, including cross sections, on  $\pi^0$  production in H are given. The  $\pi^0$  meson has rest energy of ~135 Mev, is of strong nuclear interaction, and disintegrates into two photons. Its spin is zero or an integer  $\geq 2$ . The photomeson-production cross section on nucleons is roughly one-third of the production process for  $\pi^+$ . The excitation function of the  $\pi^0$  production starts more slowly from threshold and thus exhibits a higher order contact near threshold as compared to charged-photomeson production. The angular distribution for  $\pi^0$  photomesons at a given photon energy is strongly peaked forward. The Z dependence of production, other than for exclusion-principle effects, of  $\pi^0$  and  $\pi^+$  are in agreement. The experimental

evidence is briefly compared to the predictions of charge-symmetrical meson theory, and it is concluded that there exists no theoretical study of  $\pi^0$  photoproduction which is free from logical inconsistencies and which fits all the experimental data as they are known at present.

318

Radiation Lab., Univ. of Calif.

DECAY OF THE  $\pi$  MESON; by M. Ruderman. Oct. 24, 1951. 6p. (UCRL-1513)

The decay of the charged  $\pi$  meson through virtual nucleon pairs and the annihilation of a pair with the creation of a neutrino and an electron or  $\mu$  meson is permitted by the accepted coupling between these particles. The conservation of angular momentum and parity together with Furry's theorem forbids the decay for most choices of the meson field and the  $\beta$ -decay coupling. Assuming the  $\pi$  meson to be a pseudoscalar meson at rest, the  $\beta$  coupling must be  $\alpha_1\alpha_2\alpha_3$  or  $\alpha_1\alpha_2\alpha_3\alpha_4$ . Therefore, only the axial vector or pseudoscalar  $\beta$ -decay theories can lead to the pseudoscalar  $\pi \rightarrow e, \nu$  decay. If electrons and  $\pi$  mesons are similarly coupled to nucleons, a pseudoscalar matrix element in  $\beta$  decay leads to an electron decay 5 times as often as a  $\mu$  decay, but for axial vector it is shown that  $\pi \rightarrow \mu, \nu$  is  $10^4$  times as probable as  $\pi \rightarrow e, \nu$ . The decay of the pseudoscalar  $\pi$  into a photon, electron (or a meson), and a neutrino is not limited by such rigid selection rules.

319

Radiation Lab., Univ. of Calif.

SCATTERING OF NEGATIVE  $\pi$  MESONS IN ALUMINUM, COPPER, AND LEAD (abstract); by Harry H. Heckman and Walter H. Barkas. Oct. 23, 1951. 1p. (UCRL-1522)

The report is reproduced here in its entirety.

A new technique is being used to measure nuclear scattering cross sections of  $\pi^-$  mesons as they traverse a semi-infinite scatterer. A stripped nuclear emulsion is embedded in the scatterer, exposed to an incident beam of  $50_{-15}^{+15}$ -Mev  $\pi^-$  mesons, and scanned. Most of the mesons stop at the expected distance from the absorber edge as determined from the range-energy relation. A few mesons are found smaller depths of penetration and are attributed to large-angle scattering. Mesons traveling opposite (90° to 180°) to the direction of the incident beam are attributed to nuclear scattering and are used in the cross-section calculation. The assumptions in this calculation are: (a) spherically symmetric nuclear scattering, and (b) nuclear scattering cross section independent of meson energy from 30 to 60 Mev. There is no geometrical correction factor, i.e., the cross section is proportional to the ratio of the backward flux to incident flux, both of which are observed in the same strip of emulsion. The analysis does not distinguish between elastic and inelastic scattering. The total (elastic and inelastic) nuclear scattering cross section for  $\pi^-$  mesons in the energy interval  $40_{-10}^{+20}$  Mev is being studied for Al, Cu, and Pb. A preliminary value for Cu is  $560 \pm 160$  mb.

320

Radiation Lab., Univ. of Calif.

RANGE STRAGGLE OF  $\mu^+$  MESONS (abstract); by F. M. Smith, W. Birnbaum, and W. H. Barkas. Oct. 24, 1951. 1p. (UCRL-1523)

The report is reproduced here in its entirety.

The present study is being conducted on the monoenergetic  $\mu^+$  mesons arising from decay of  $\pi^+$  mesons stopping in photographic emulsion. In 200  $\mu$  emulsion ~17% of these  $\mu^+$ s will lose all of their kinetic energy in the film. The track lengths of those  $\mu$  mesons which visibly stop are measured with regard to total range. The shrinkage factor of the processed film has been determined in order to find the proper depth component of the range. Preliminary results on the



range distribution of 260 tracks are in good agreement with the predictions of straggling theory; The standard deviation of the range is found to be 4.4%, and the distribution is not inconsistent with an assumption of normality. Recent reports (Barkas, Washington meeting of *Am Phys. Soc.*, (April 1951), UCRL-1285; Fry, *Phys. Rev.* **83**, 1268 (1951); Gross, private communication) indicate the existence of  $\mu$  tracks of very short range. Although some of these might conceivably lie within the tail of the distribution, others are too far out to be included and presumably must be attributed to another process.

321

Radiation Lab., Univ. of Calif.

PHOTO PRODUCTION OF NEGATIVE PIONS FROM DEUTERIUM (abstract); by R. E. LeLevier. Oct. 24, 1951. 1p. (UCRL-1525)

The report is reproduced here in its entirety.

The meson-energy spectrum for fixed recoil angles of meson and proton in photo- $\pi^-$  production from deuterium was calculated using the impulse approximation (Chew, *Phys. Rev.* **80**, 196 (1950) and a phenomenological spin-dependent interaction (Lax and Feshbach, *Phys. Rev.* **81**, 189 (1951)). The spectrum is peaked near the unique energy which results at given free neutron production angles. The main portion of the spectrum is essentially given by  $\phi_0^2(k)$  where  $\phi_0(k)$  is the Fourier transform of the deuteron wave function and  $k$  is the momentum of the original proton in the deuteron. For a given meson energy the conservation laws determine  $k$ . If the final protons are in a singlet spin state there is a sharp rise in the spectrum at the maximum possible meson energy. This is due to a large increase in the phase-space factor and to the  $^1S$  proton-proton interaction. The experimental ratio of the height of the "spike" to that of the central peak would provide a measure of the spin flip process since there is no spike if the final protons are in a spin triplet state.

322

Radiation Lab., Univ. of Calif.

CAPTURE OF  $\mu^-$  MESONS IN NUCLEAR EMULSIONS (abstract); by D. F. Sherman, Harry H. Heckman, and Walter H. Barkas. Oct. 24, 1951. 1p. (UCRL-1529)

The report is reproduced here in its entirety.

The behavior of  $\mu^-$  mesons produced in the cyclotron has been investigated to verify deductions from cosmic-ray studies. A beam of  $\mu^-$  mesons has been obtained inside the 184-in. cyclotron by bombarding a Be target with the proton beam. Because many of the  $\pi$  mesons so produced disintegrate near the target, the target region acts as a diffuse source of  $\mu$  mesons. A channel was constructed to select a beam of negative mesons of momentum  $130 \pm 3$  Mev/c. An absorber which stops the  $\pi$  mesons of momentum up to 140 Mev/c was placed in this beam, and an Ilford C-2 emulsion in a wedge absorber was placed behind it to detect  $\mu^-$  mesons which penetrated the absorber.  $\mu^-$  mesons were found ending in the plate with a density of about 4000 per cc in the energy interval 54 to 70 Mev. About 6% of these form one-prong stars of low energy. This agrees with results of George and Evans (*Proc. Phys. Soc. (London)* **44A**, 193 (1951)). An additional 35% shows evidence of nuclear capture in the form of two pronglets, each about a micron long, or a "blob" at the end of the track.

323

Radiation Lab., Univ. of Calif.

THE PHOTOPRODUCTION OF NEGATIVE MESONS FROM DEUTERIUM (abstract); by Richard Madey, Kenneth C. Bandtel, and Wilson J. Frank. Oct. 1951. 1p. (UCRL-1537)

The report is reproduced here in its entirety.

Evidence will be presented for the observation of the photomeson production process  $\gamma + n \rightarrow \pi^- + p$ . The photon

source is the 322-Mev bremsstrahlung of the Berkeley synchrotron. Pion-proton coincidences were observed at pion laboratory angles of 90 and 120°. Correlated proton angles are predicted from the conservation laws for the photoproduction of a pion from a free neutron at rest. The predicted pairs of correlated meson and proton angles remain very nearly the same over all photon energies in the region of interest. Furthermore, the upper energy limit of the bremsstrahlung spectrum restricts the protons to an angular region in the forward direction within less than about 60° from the beam direction. The effect of the loose binding of the neutron in deuterium imparts a calculable smearing of the angle and energy correlations. When the angle of the proton telescope is varied to 7° on either side of the associated correlation angles, the difference in the counting rates between heavy water and ordinary water shows a well-defined peak at the predicted proton angles of 31.5 and 20°.

324

Radiation Lab., Univ. of Calif.

THE PRODUCTION OF PHOTO-MESONS FROM HELIUM (abstract); by Mark J. Jakobson, Alvin G. Schulz, and R. Stephen White. Oct. 31, 1951. 1p. (UCRL-1545)

The report is reproduced here in its entirety.

A study has been made of the mesons produced from helium and hydrogen by bombarding a low-temperature, high-pressure target with the 318  $\pm$  10 Mev bremsstrahlung beam of the Berkeley synchrotron.  $\pi^+$  mesons were detected by scintillation counters, using  $\pi^- \mu$ ,  $\pi^- \beta$ , and  $\pi^- \mu \beta$  delayed coincidence detection. Ilford C2, 200  $\mu$  nuclear emulsions were used to obtain the  $\pi^-/\pi^+$  ratio. Measurements were made at angles of 45, 90, and 135° to the photon beam direction. The minimum energy detected was about 27 Mev due principally to the energy loss of the mesons in the target walls. The mean values of the minus-plus ratio from helium at 45, 90, and 135° are:  $0.99 \pm 0.15$ ,  $1.09 \pm 0.14$ , and  $1.00 \pm 0.12$ , respectively. Differential and total cross sections for  $\pi^+$  production were evaluated extrapolating from the minimum energy detected to zero meson energy. The results are presented in the following table: (not corrected for nuclear absorption in the absorbers)

Gas	$\frac{d\sigma(\theta)}{d\Omega} \text{ cm}^2(\text{steradian})^{-1}(\text{equivalent quantum})^{-1}(\text{proton})^{-1}$			$\text{cm}^2(\text{equivalent quantum})^{-1}(\text{proton})^{-1}$
	45° $\pm$ 16°	90° $\pm$ 19°	135° $\pm$ 20°	
Helium	$2.5 \pm 0.2 \times 10^{-30}$	$4.0 \pm 0.3 \times 10^{-30}$	$3.2 \pm 0.2 \times 10^{-30}$	$4.1 \pm 0.2 \times 10^{-30}$
Hydrogen	$5.5 \pm 0.5 \times 10^{-30}$	$7.4 \pm 0.5 \times 10^{-30}$	$5.4 \pm 0.4 \times 10^{-30}$	$7.8 \pm 0.4 \times 10^{-30}$
Ratio $\frac{\text{Helium}}{\text{Hydrogen}}$	$0.45 \pm 0.06$	$0.54 \pm 0.05$	$0.59 \pm 0.06$	$0.53 \pm 0.04$

325

TOWARD A THEORY OF THE ORIGIN OF MANY PARTICLES FROM A SINGLE EVENT. I. Pomeranchuk. *Doklady Akad. Nauk S.S.S.R.* **78**, No. 5, 889-91(1951) June 11. (In Russian)

An expression for the probability of multiple meson production in high-energy (cosmic-ray) events is derived and discussed.

326

ON THE CONVERSION OF A CHARGED  $\pi$  MESON INTO A NEUTRAL MESON BY COLLISION WITH A PROTON OR DEUTERON. V. B. Berestetskiĭ and I. Ya. Pomeranchuk. *Doklady Akad. Nauk S.S.S.R.* **77**, No. 5, 803-6(1951) Apr. 11. (In Russian)

Mathematical expressions are derived for the cross sections according to pseudoscalar, pseudovector, and hybrid couplings.

327

EVIDENCE FOR THE DECAY OF A NEGATIVE  $\pi$  MESON IN A PHOTOGRAPHIC EMULSION. W. F. Fry. *Phys. Rev.* **84**, 385-6(1951) Oct. 15. (Letter to the editor)

Iford C2 200- $\mu$  plates were exposed, in a spiral-orbit spectrometer, to the meson beam from the Berkeley cyclotron. One event was found which is consistent with the decay in flight of a negative  $\pi$  meson having 50-kev energy at the time of decay. The  $\mu$ -meson track is 828- $\mu$  long and makes an angle  $<20^\circ$  with the  $\pi$ -meson track. A photomicrograph is shown.

328

A THEORETICAL ANALYSIS OF THE PROCESS  $\pi^+ + d \rightleftharpoons p + p$ . Geoffrey F. Chew, M. L. Goldberger, J. M. Steinberger, and C. N. Yang. *Phys. Rev.* **84**, 581-2(1951) Nov. 1. (Letter to the editor)

The reactions  $\pi^+ + d \rightleftharpoons p + p$  are analyzed in the spirit of the impulse approximation. It is shown that the predominantly  $\cos^2 \theta$  angular distribution can be understood without great difficulty and that the reaction may be used to obtain information on the high-momentum components of the n-p and p-p interaction. The meson wave function is apparently strongly perturbed in the region near the nucleon.

329

THE ABSORPTION OF PIONS BY DEUTERONS. R. Durbin, H. Loar, and J. Steinberger. *Phys. Rev.* **84**, 581(1951) Nov. 1. (Letter to the editor)

The energy dependence of the angular distribution and of the total cross section for the reaction  $\pi^+ + d \rightarrow p + p$  has been investigated with mesons of energy 25 to 53 Mev. Differential cross sections, total cross sections, and angular distributions giving the best fit to  $\alpha + \beta \cos^2 \theta$  are tabulated. There is no large change in the angular distribution in the energy range 25 to 53 Mev for the incident meson in the center-of-mass system. The total cross section increases by a factor  $2.25 \pm 0.32$ . The kinematical factors are considered, and it is concluded that the meson-nucleon interaction must increase approximately as the square of the meson momentum.

330

NON-DECELERATION CREATION OF MESONS. V. L. Indenbom. *Zhur. Eksptl'. i Teoret. Fiz.* **21**, No. 6, 737-47(1951) June. (In Russian)

A theoretical study of meson emission on the passage of fast nucleons (hundreds of Mev energy) through heavy nuclei is presented. The author refers to the process as nondecelerated or unbraked emission. The cross section is related to the nuclear mass number by the factor  $A^{2/3}$ .

## METEOROLOGY

331

FREQUENCY DISTRIBUTIONS OF VELOCITIES IN TURBULENT FLOW. F. N. Frenkiel. *J. Meteorol.* **8**, 316-20 (1951) Oct.

A conventional anemometer used in the atmosphere or in a wind tunnel measures velocities projected on a plane independently of their directions in the plane. The relation between the frequency distribution of those velocities and the frequency distribution of the turbulent components parallel to the direction of the mean velocity is discussed. At small intensities of the longitudinal turbulence the two distributions are approximately the same. However, at intensities of turbulence of the order of those measured in the atmosphere, the difference between the two frequency distributions becomes appreciable. Some experimental frequency distributions of wind velocities are presented, and the intensities of atmospheric turbulence are determined from the experiments. (auth)

## NEUTRONS

332

Atomic Energy Research Establishment, Harwell, Berks (England)  
INFLUENCE OF A CYLINDRICAL CHANNEL ON A PERIODIC

NEUTRON DENSITY DISTRIBUTION; by B. Davison. [nd] 22p. (AERE-T/R-738)

We consider a cylindrical channel passing parallel to the z-axis through an infinite, slightly multiplying medium, scattering isotropically and without change in energy, in which the neutron density is of the form

$$\rho(x, y, z) = \psi(\sqrt{x^2 + y^2}) e^{i\alpha z}$$

and the number of secondaries per collision is adjusted so that in absence of the channel the neutron density would become independent of the lateral coordinates. It is shown that in this case the linear extrapolation length  $\lambda$ , defined by

$$\lambda = \frac{\rho_{as}}{\text{grad } \rho_{as}} \Big|_{\text{at the walls of the channel}}$$

is given, for small  $\alpha$ , by

$$\lambda = \frac{l}{\alpha^2 a(a+l)} + \frac{3\pi}{8} \frac{1}{|\alpha|} \frac{al}{(a+l)^2} + O((\log \alpha a)^2)$$

where  $a$  is the channel radius and  $l$  is the mean free path in the scattering medium. (auth)

## NUCLEAR PHYSICS

333

A NEW STATISTICAL THEORY OF ATOMIC NUCLEI. P. Román. *Acta Phys. Hung.* **1**, No. 2, 107-14(1951).

The internucleonic meson field is assumed to be static, central, and scalar, and a statistical distribution of nucleons is taken. The binding energies of nuclei are calculated after obtaining an approximate solution of the potential equation. The energy expression thus obtained also automatically gives the surface tension of the nuclei. Numerical results are given for the binding energies of  $C^{13}$ ,  $N^{14}$ ,  $N^{15}$ ,  $Ne^{20}$ ,  $Al^{27}$ ,  $S^{32}$ ,  $Ca^{42}$ ,  $Fe^{56}$ ,  $Mo^{97}$ ,  $Sn^{124}$ ,  $Gd^{160}$ ,  $Pt^{196}$ ,  $Rn^{220}$ , and  $U^{238}$ . Deviations from experimental values do not exceed 7.5% even for the heaviest nuclei.

## NUCLEAR PROPERTIES

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Los Alamos Scientific Lab.

ABSORPTION CROSS SECTIONS FOR 19.5-MEV QUANTA (abstract); by Arthur I. Berman. [nd] Decl. Nov. 1, 1951. 1p. (AEC-D-3277; LADC-1066)

Total cross sections for 19 elements, from hydrogen to uranium, were found by a photonuclear detector method (Adams, *Phys. Rev.* **74**, 1707(1948)) which measured the  $C^{11}$  activity induced by betatron bremsstrahlung. The penetration of the radiation (maximum energy, 20.4 Mev) through the absorbers was detected by the  $C^{12}(\gamma, n)C^{11}$  reaction (threshold, 18.7 Mev) in polyethylene. The use of high counting rates and dual monitor-detector Geiger counters, which completely or partially canceled errors due to timing, intensity fluctuations, and uncertainty in counter resolving time theory, reduced most random probable errors to approximately 0.4%. Systematic errors added about 0.4% to this. The narrow band width permitted a determination of the proportion of counts due to secondary effects. If the approximate high-energy validity of the Klein-Nishina-Compton cross section (verified here to within 7%) is assumed, together with recent photonuclear data, then the theoretical (essentially Bethe-Heitler formula including screening) and experimental pair cross sections are related by  $(\sigma_t - \sigma_e)/\sigma_t = (1.6 \pm 0.2 \times 10^{-5})Z^2$ .

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Wisconsin Univ.

EVIDENCE FOR NON-ADDITIVITY OF NUCLEON MOMENTS; by R. G. Sachs and M. Ross. [nd] 6p. (AECU-1704)



Energies, conversion coefficients, lifetimes of isomeric states, and spin changes from the literature are tabulated for the isomeric magnetic-dipole transitions in  $\text{Sn}^{117}$ ,  $\text{Sn}^{119}$ ,  $\text{Te}^{121}$ ,  $\text{Te}^{123}$ ,  $\text{Te}^{125}$ ,  $\text{Xe}^{131}$ , and  $\text{Ba}^{133}$ . These data are interpreted as evidence for a departure from additivity of the intrinsic nucleon moments, and they impose certain restrictions on the possible forms of the interaction moment. Modifications of the intrinsic moments produced by interactions between pairs and by the neutron-proton exchange potential are considered.

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Harvard Univ. and Brookhaven National Lab.

LONG RANGE PROTON-PROTON TENSOR FORCE; by Norman F. Ramsey. Oct. 4, 1951. 4p.

The molecular-beam magnetic-resonance experiments with  $\text{H}_2$  provide an accurate measurement of the tensor interaction between two protons  $\frac{3}{4}$  Å apart. The magnetic part of this interaction depends only upon the magnetic moment of the proton and the mean inverse cube of the internuclear spacing. The magnetic moment of the proton is accurately known from nuclear resonance experiments, while the internuclear spacing can be inferred from spectroscopic data on  $\text{H}_2$ . Therefore a comparison of the value computed in this way with the experimental value will either detect or set an upper limit to the long-range nonmagnetic tensor interaction between two protons. The magnetic part and experimental part of the proton-proton interaction of the form  $K(r)S_{12}$ , where  $S_{12}$  is the usual tensor operator, agree within the estimated error. Consequently, nonmagnetic or nuclear part must be less than  $6 \times 10^{-25}$  ergs or  $4 \times 10^{-19}$  Mev. This result means that if there is a Yukawa type field giving rise to a tensor force and a field particle weighing less than  $\frac{1}{10}m_e$ , the coupling,  $g^2/\hbar c$ , of the nucleons to the field must be less than  $4 \times 10^{-8}$  and the potential from this field of two protons  $2.8 \times 10^{-13}$  cm apart must be less than  $3 \times 10^{-16}$  Mev.

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Rochester Univ.

PROTON BREMSSTRAHLUNG AT 140 MEV; by Richard Wilson. Oct. 9, 1951. 27p. (NYO-898)

The high energy gamma rays arising from 140-Mev proton bombardment of several elements has been studied using a scintillation counter telescope to detect secondary electrons. The angular distribution is consistent with an approximately isotropic distribution in the center of mass system if we assume the bremsstrahlung to come from p-n collisions inside the nucleus. This is in disagreement with a phenomenological potential treatment of the p-n force or the scalar meson theory. The form of the spectrum is found to be consistent with the  $d\nu/\nu$  shape, and the dependence on  $Z$  much as would be expected from an opaque nucleus with only the neutrons contributing to the bremsstrahlung. (auth)

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Rochester Univ.

AN ENERGY LEVEL IN  $\text{Li}^6$ ; by William M. Harris. Oct. 26, 1951. 4p. (NYO-3033)

A level has been determined in  $\text{Li}^6$  at  $2.12 \pm 0.05$  Mev. A single-focusing  $180^\circ$  magnetic spectrograph was used in conjunction with a 7-Mev proton beam to measure the energy spectrum of protons scattered from a  $\text{LiF}$  target enriched in  $\text{Li}^6$ . Eastman NTA plates were used for detection.

339

Oak Ridge National Lab.

ONE-THREE GAMMA-GAMMA ANGULAR CORRELATION; by G. B. Arfken, L. C. Biedenharn, and M. E. Rose. Issued Nov. 13, 1951. 25p. (ORNL-1103)

Theoretical calculations are made of angular correlation of the first and third  $\gamma$  rays in a cascade. The angular cor-

relation functions are tabulated for various possible values of the ground-state spin. Two cases are mentioned in which the one-three  $\gamma$ - $\gamma$  angular correlation can give new information which cannot be obtained from the correlation of consecutive  $\gamma$  rays. 5 graphs, 3 tables.

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NUCLEAR PROPERTIES FROM MICROWAVE MEASUREMENT ON LINEAR XYZ MOLECULES. William Low, Ph.D. thesis, Columbia Univ., 1950.

The following abstract is reproduced in its entirety from Micromfilm Abstracts 10, No. 3, 187-8(1950).

A microwave spectroscopy of the Stark modulation type with a recording ammeter and slow sweep was used to detect and measure the frequencies and intensities of the very weak isotopic lines of  $\text{O}^{17}\text{CS}$  and  $\text{OCS}^{36}$ . These measurements permit the evaluation of the masses and abundance of  $\text{O}^{17}$  and  $\text{S}^{36}$ . The mass of  $\text{O}^{17} = 17.00455 \pm 0.0002$  and that of  $\text{S}^{36} = 35.97834 \pm 0.0004$ . The abundance of  $\text{O}^{17}$  is 0.039%, in agreement with accepted values, but that of  $\text{S}^{36}$  is 0.0136  $\pm$  0.001%, which disagrees with Nier's estimate of 0.016%. Nuclear masses could be more accurately determined from this type of measurement if certain vibration-rotation constants were known. However, inconsistencies have been found in various measurements of the vibration-rotation constants in  $\text{OCS}$ . These inconsistencies are explained quantitatively as interaction of nearly degenerate vibrational levels of the same symmetry. Using microwave measurements of sulfur and chlorine masses and previously known nuclear reactions, the effect of nuclear shell structure on masses in the region of 20 neutrons or protons was investigated. It was found that nuclei with 20 neutrons or protons do not show any special stability except in the case of  $\text{Ca}^{40}$ . This is contrary to expectations from present "single-particle" nuclear shell models, which assign a closed shell and, hence, stability to nuclei with 20 neutrons or protons. No hyperfine structure was observed in the lines of  $\text{O}^{17}\text{CS}$  or  $\text{OCS}^{36}$ . Since the quadrupole coupling is less than 5 Mc, this is a good indication that the spin of  $\text{S}^{36}$  is zero. No definite assignment of spin of  $\frac{1}{2}$  for  $\text{O}^{17}$  is possible, as the quadrupole moment is expected to be small.

341

THEORY OF THE WIDTH OF NUCLEAR QUADRUPOLE RESONANCE LINES OF  $\text{Cl}^{35}$ . Yves Ayant. Compt. rend. 233, 949-51(1951) Oct. 22. (In French)

Two mechanisms contribute to widening of nuclear quadrupole resonance lines: fluctuations of the inhomogeneous electric field coupled with the nucleus, and spin-spin interaction. A formula for the latter effect is derived and applied to the case of  $\text{Cl}^{35}$  in  $\text{CHCl}_3$  (considering only interactions between nuclei of the same molecule) and  $p\text{-C}_6\text{H}_4\text{Cl}_2$ . Values of 2.6 and 2.4 kc, respectively, are calculated for the resonance-line widths in the two molecules. Since experimental values of the order of 4 kc have been measured by Buyle-Bodin and Dautreppe (Compt. rend., in press), the importance, if not preponderance, of the spin-spin effect is indicated.

342

$^{176}_{71}\text{Lu}$  AND THE NUCLEAR SHELL MODEL. P. F. A. Klinkenberg. Physica 17, 715-16(1951) July. (Letter to the editor)

Consideration of errors in published measurements of the magnetic moment of  $\text{Lu}^{176}$  leads to adoption of  $\mu = 4.2 \pm 0.8$  nuclear magnetons for this nuclide. Comparison of this value with that calculated according to the  $jj$  model of nuclear shells for all possible combinations of proton and neutron states shows that the odd proton is in the  $6h_{11/2}$  and that the odd neutron is in the  $7i_{13/2}$  state. The most probable angular momentum is 10, although 9 or 11 is pos-

sible. The existence of a stabilizing interaction between the two odd nucleons is suggested.

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# QUADRUPOLE RESONANCE FREQUENCY OF $I^{127}$ NUCLEI IN CRYSTALLINE COVALENT IODINE COMPOUNDS.

H. G. Dehmelt. *Z. Physik* **130**, No. 3, 356-70(1951). (In German)

Absorption lines in the decimeter region have been measured for  $\text{SnI}_4$ , trans-1,2-diiodoethylene,  $\text{CH}_3\text{I}$ ,  $\text{ICN}$ ,  $\text{ICl}$ , and  $\text{I}_2$ . These lines are the result of induced transitions between terms arising from the coupling of the inhomogeneous electric field of the molecular electron shells and the electric quadrupole of the  $\text{I}$  nucleus. The results are compared to the analogous lines found in dichloroethylene. Deviation from the interval rule based on exact rotation symmetry, quadrupole coupling constants, and Zeeman effect in a  $\text{SnI}_4$  single crystal are discussed.

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# A CONTRIBUTION TO THE INVESTIGATION OF THE PURE NUCLEAR QUADRUPOLE SPECTRA IN CRYSTALS.

H. Krüger. *Z. Physik* **130**, No. 3, 371-84(1951). (In German)

The energy possessed by a nucleus of spin  $I = 3/2$  or  $5/2$  as a consequence of the coupling of its electric quadrupole moment with an inhomogeneous electric field not rotational symmetrical is calculated. Observation of the ratio of the quadrupole transition frequencies,  $\nu(\pm 5/2 \leftrightarrow \pm 3/2)$  to  $\nu(\pm 3/2 \leftrightarrow \pm 1/2)$ , for the case  $I = 5/2$  permits calculation of the deviation of the field gradient from rotational symmetry. A theoretical investigation of the magnetic splitting of nuclear quadrupole resonance transitions in single crystals has been undertaken; the doubly degenerate term with  $m_2 = \pm 1/2$  has a linear Zeeman effect in a magnetic field perpendicular to the electric field axis.

345

THE MAGNETIC MOMENT OF  $\text{As}^{75}$ . S. S. Dharmatti and H. E. Weaver, Jr. *Phys. Rev.* **84**, 367(1951) Oct. 15. (Letter to the editor)

Nuclear magnetic resonances of  $\text{As}^{75}$  with a natural line width at half-maxima of about 8 gauss have been observed in a solution of  $2M \text{ Na}_2\text{HAsO}_4$  in  $3M \text{ NaOH}$  in which the compound  $\text{Na}_3\text{AsO}_4$  is presumably formed. The resonant frequency was compared to that of  $\text{Na}^{23}$  present in the solution with the result  $\nu(\text{As}^{75})/\nu(\text{Na}^{23}) = 0.64745 \pm 0.00015$ . The magnetic moment of  $\text{As}^{75}$  was calculated as  $+1.4347 \pm 0.0003$ . Arsenic signals were detected in both liquid and solid phases of the sample with a shift of about  $1/10^6$  toward higher fields for the solid state. Nuclear resonances of  $\text{As}^{75}$  were not observed in other arsenic compounds.

346

ANGULAR CORRELATION IN MAGNETIC FIELDS. Kurt Alder. *Phys. Rev.* **84**, 369-70(1951) Oct. 15. (Letter to the editor)

A general expression is derived for the influence of magnetic fields (from the electron shell, from neighboring atoms, or from an external source) on the angular correlation of two successively emitted nuclear particles. The whole influence of the magnetic field is contained in an attenuation factor, which is calculated for the cases of a weak and a strong field and further simplified for certain special cases.

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THE DETERMINATION OF THE MAGNETIC MOMENT OF AN EXCITED NUCLEAR LEVEL ( $\text{Cd}^{111}$ , 247 kev). H. Aepli, H. Albers-Schönberg, A. S. Bishop, H. Frauenfelder, and E. Heer. *Phys. Rev.* **84**, 370-1(1951) Oct. 15. (Letter to the editor)

The g factor and the magnitude and sign of the magnetic moment of the intermediate (247 kev) level in the  $\gamma\text{-}\gamma$  cascade

in  $\text{Cd}^{111}$  have been determined by measuring the influence of an external magnetic field on the angular correlation of the  $\gamma$  rays. The g factor is  $-(0.34 \pm 0.09)$ , thus confirming the assignment  $d_{5/2}$  for the 247-kev level. The magnetic moment is  $-(0.85 \pm 0.22)$  nuclear magnetons.

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A COMMENT ON THE VALIDITY OF THE BLOCH FORMULATION FOR THE INTERPRETATION OF NUCLEAR MAGNETIC RESONANCE PHENOMENA. E. Strick, R. Bradford, C. Clay, and A. Craft. *Phys. Rev.* **84**, 363-4(1951) Oct. 15. (Letter to the editor)

By means of periodically repeated pulses for the determination of the relaxation times of a system, four distinct transient effects have been observed: (1) an exponential decay, (2) modification of this exponential decay by magnetic-field inhomogeneities, (3) the existence of a mirror signal, and (4) the existence of signals on each side of the resonance signal (side bands). Investigations of the last three effects have shown that they can be described by appropriate solutions of the Bloch equations.

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RECOIL MOMENTA IN THE DECAY OF  $\text{Be}^7$  AND THE NEUTRON-HYDROGEN MASS DIFFERENCE. Philip Bartlett Smith. Ph.D. thesis, University of Illinois, 1950.

The following information appears in *Microfilm Abstracts* **10**, No. 4, 270-1(1950).

The maximum energy of the recoil momenta in the decay of  $\text{Be}^7$  was found to be  $56.6 \pm 1.0$  ev. Using this end-point energy and the Q value for the  $\text{Li}^7(p,n)\text{Be}^7$  reaction, the n-H mass difference was determined to be  $788 \pm 8$  kev.

350

ASYMPTOTIC BEHAVIOR OF ANGULAR CORRELATION FUNCTIONS. W. Opechowski. *Phys. Rev.* **84**, 590-1(1951) Nov. 1. (Letter to the editor)

It is proved mathematically that, for large total angular momenta of the initial state of the system and of the particle emitted in the first transition, the correlation function is always the same, no matter what the nature and properties of the particle are, provided all other characteristics of the cascade process are the same. Although the asymptotic form of the correlation function does not depend on the total angular momentum quantum numbers of the initial state of the system and of the first particle, it does still depend, classically speaking, on the angle between the two angular momenta.

351

COUPLING AMONG NUCLEAR MAGNETIC DIPOLES IN MOLECULES. H. S. Gutowsky, D. W. McCall, and C. P. Slichter. *Phys. Rev.* **84**, 589-90(1951) Nov. 1. (Letter to the editor)

Consideration is given to possible interpretations of multiple nuclear magnetic resonance lines which have been reported in several liquids, such as the Sb resonances in aqueous  $\text{NaSbF}_6$  (Proctor and Yu, *Phys. Rev.* **81**, 20(1951)). Flaws are pointed out in both the rotational-hindrance and direct second-order dipolar-interaction mechanisms, and it is proposed that the splittings arise from a second-order interaction between the nuclear magnetic moments and some magnetic field internal to the molecule.

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ANGULAR CORRELATION IN THE REACTION  $^6\text{Li}(d,p)^7\text{Li}^*(\gamma)^7\text{Li}$ . J. O. Newton. *Proc. Phys. Soc. (London)* **64A**, 938-9(1951) Oct. (Letter to the editor)

The angular correlation between the protons and  $\gamma$  rays in the reaction  $\text{Li}^6(d,p)\text{Li}^{7*}(\gamma)\text{Li}^7$  was measured. The experiment determined the angular correlation as isotropic, and the spin of  $\text{Li}^{7*}$  as  $1/2$ . This value agrees with the results obtained by Rose and Wilson (*Phys. Rev.* **78**, 68(1950)) and also the value predicted by Mayer from the shell model.



## NUCLEAR REACTORS

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[Chicago Univ.]

EXPERIMENTAL PRODUCTION OF A DIVERGENT CHAIN REACTION; by E. Fermi. [nd] Decl. Nov. 7, 1951

48p. (AECD-3269; CP-413; A-497)

Details of construction and operation of the first chain-reacting pile, consisting of a U-graphite lattice constructed in the West Stands Laboratory, University of Chicago, during October-November 1942 and operated for the first time on Dec. 2, 1942, are reported. Results of measurements performed during construction are given, methods used to test materials used in the pile are discussed, and monitoring and control are described. The expected and observed critical dimensions are compared, and the energy emitted by the pile is discussed. 18 figures.

354

Carbide and Carbon Chemicals Co., K-25

EFFECT OF INTERACTION ON CRITICAL MASS; by R. L. Macklin. Issued Aug. 31, 1950. Decl. with deletions Sept. 27, 1951. 7p. (AECD-3274; K-666)

The formula  $M \leq M_0(1-f)^{3/2}$ , where  $M_0$  is the critical mass in a cubical reactor and  $M$  is the safe mass in a reactor, with  $f$  the total maximum solid angle, is derived for the conservative approximation of the lowering of the critical mass of a bare assembly of fissionable materials caused by the proximity of similar assemblies.

355

THE NRX PILE AT CHALK RIVER. W. B. Lewis. *Phys. Today* 4, No. 11, 12-15(1951) Nov.

The neutron flux, structure, and control system of the NRX pile are discussed. Isotope production in the pile, facilities provided for irradiation of samples, and several research projects utilizing the high flux of thermal neutrons are described.

356

ON DEFLECTION AT  $n = 1$  IN THE SYNCHROCYCLOTRON. Donald R. Hamilton and Harry J. Lipkin. *Rev. Sci. Instruments* 22, 783-92(1951) Oct.

This paper discusses the theory of a possible method of synchrocyclotron beam deflection in which the orbits expand until the point of maximum  $Hr(n=1)$  is reached, after which the ions escape and spiral outward. These spirals should have a uniform starting radius and a small pitch in order to give deflection efficiency of the order of 100%; it is shown that this requires a flat maximum of  $Hr$  at  $n = 1$ , and small amplitude of radial oscillation. The radial and vertical oscillations of the beam and the couplings thereof are discussed in detail. It appears that the only field inhomogeneities which must be carefully minimized are those at  $n = 1$  and  $n = 0$ . Limits on radial and vertical oscillations in the immediate vicinity of the ion source are set but the origins thereof in phenomena other than field inhomogeneity are not discussed. (auth)

## NUCLEAR TRANSFORMATION

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Radiation Lab., Univ. of Calif.

SLOW NEUTRON FISSION OF  $\text{Am}^{242}$ ,  $\text{Am}^{242m}$ , AND  $\text{Am}^{243}$ ; by K. Street, Jr., A. Ghiorso, and S. G. Thompson. Mar. 15, 1951. Decl. Nov. 1, 1951. 4p. (AECD-3268; UCRL-1185)

A sample of  $\text{Am}^{241}$  was irradiated with pile neutrons. Mass spectrographic analysis of this sample showed 99%  $\text{Am}^{241}$ , 0.5%  $\text{Am}^{242}$ , and 0.5%  $\text{Am}^{243}$ . From these data the following approximate cross sections were calculated: cross section for formation of  $\text{Am}^{242}$ , ~50 barns; neutron capture cross section of  $\text{Am}^{242}$  to form  $\text{Am}^{243}$ , ~2000 barns;

total cross section for destruction of  $\text{Am}^{242}$ , ~8000 barns; fission cross section of  $\text{Am}^{242}$ , ~6000 barns. These results agreed with measurements of the fissionability of Am samples containing various amounts of  $\text{Am}^{242}$  and  $\text{Am}^{243}$  made with a fission counter in the Argonne heavy water pile. The fission cross section of  $\text{Am}^{242m}$  was calculated to be about 2000 barns.

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Atomic Energy Research Establishment, Harwell, Berks (England)

SEARCH FOR  $^7\text{Be}$  IN URANIUM FISSION; by G. B. Cook. July 11, 1951. 3p. (AERE-C/R-758)

The report is reproduced here in its entirety.

Recent studies of the fission of U with slow neutrons by the photographic technique have shown the existence of ternary and quaternary fission (San Tsiang Tsien, Chastel, Zah Wei Ho, and Vigneron, *Compt. rend.* 223, 986, 1119 (1946); 224, 1056 (1947)). In the former, there appear to be two heavy particles and one light emitted with masses of the lightest group estimated to be between 4 and 9. It has also been suggested that  $\text{Be}^8$  may be a member of this group (Goward, Titterton, and Wilkins, *Nature* 164, 661 (1949)). The only isotope in this region suitable for a radiochemical approach to the problem is  $\text{Be}^7$  with a half life of 52.9 days (Segrè and Wiegand, *Phys. Rev.* 75, 39 (1949)). Although it is on the neutron deficient side of nuclear stability, unlike any of the known fission products, it was considered worthwhile nevertheless to search for  $\text{Be}^7$  in samples of U which have been neutron-bombarded in the Harwell pile for some months.

Fifty grams of uranium oxide which had been in the pile for 3 months were dissolved in nitric acid, ~100 mg of Be as the nitrate added, the solution concentrated by evaporation and the majority of the uranyl nitrate removed by extraction with methyl isobutyl ketone. The residual aqueous solution was then treated with excess potassium hydroxide which formed soluble potassium beryllate, and insoluble potassium uranate. The solution was filtered and acidified with nitric acid, and Be hydroxide was precipitated by addition of ammonia. Sulfide-insoluble impurities were now removed by 3 scavengings with a mixture of Sb and Te sulfides (~15 mg of each). After boiling to remove  $\text{H}_2\text{S}$ , ~15 mg of Fe was added and precipitated as hydroxide in the cold with NaOH to absorb impurities forming insoluble hydroxides. The precipitate was centrifuged, the mother liquors acidified, and Be hydroxide precipitated by addition of ammonia. After the precipitate was washed it was dissolved in dilute acetic acid, and the solution evaporated to near dryness when 5 ml of glacial acetic acid was added and the solution was again evaporated (Noyes and Bray, "Qualitative Analysis for the Rarer Elements," McMillan, 1927). The basic Be acetate so formed was then extracted from the residue by several washes with chloroform. The organic solution was then washed with 0.5N nitric acid solution and with water, the washings being rejected. The Be was recovered by evaporation of the chloroform and solution of the residue in HCl. As an appreciable amount of  $\gamma$  activity was detected by a  $\gamma$ -scintillation counter, the formation and extraction of basic Be acetate was repeated, but the Be at this stage was found to be inactive. Assuming that 20 cpm of  $\text{Be}^7$  could be detected and that 11% of the  $\text{Be}^7$  disintegrations (Williamson and Richards, *Phys. Rev.* 76, 614 (1949); Turner, 76, 148 (1949)) emit a 0.48-Mev  $\gamma$  ray, a limit to the fission yield was set from the known efficiency of the  $\gamma$  counter, the chemical yield, etc., the number of fissions being determined by the amount of  $\text{Ba}^{140}$  detected. An upper limit of  $2 \times 10^{-8}\%$  was obtained. The experiment was repeated using 100 g of U metal irradiated for 1 yr. A similar chemical procedure

was used except that Na uranate was used as a scavenging agent instead of ferric hydroxide and the number of chloroform extractions of basic Be acetate was increased. No  $\gamma$  activity above background could be detected in the Be fraction. In this case the upper limit obtained for the fission yield was  $10^{-5}\%$ . Thus, assuming that ternary fission occurs to the extent of 0.003 of that of binary fission (San Tsiang Tsien, Zah Wei Ho, Vigneron, and Chastel, *Compt. rend.* 224, 272 (1947)), less than one  $\text{Be}^7$  nucleus is produced in  $3 \times 10^4$  ternary fissions.

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Laboratory for Nuclear Science and Engineering, Mass. Inst. of Tech.

NUCLEAR SHIELDING STUDIES; XIV. ENERGY LEVELS IN MEDIUM WEIGHT NUCLEI FROM THE (p,n) REACTION (Technical Report No. 54); by J. A. Lovington, J. J. G. McCue, and W. M. Preston. Sept. 1, 1951. 32p. (NP-3487)

Yields from the reactions  $\text{Cr}^{53}(\text{p},\text{n})\text{Mn}^{53}$  and  $\text{Cr}^{54}(\text{p},\text{n})\text{Mn}^{54}$  have been investigated with protons from the Rockefeller electrostatic generator, and with isotopically enriched targets. The energy resolution was less than 2 kev. Resonances in the neutron yield show the positions of energy levels in the compound nuclei  $\text{Mn}^{54}$  and  $\text{Mn}^{55}$ . The average spacing of the peaks is 4.4 kev for  $\text{Mn}^{54}$  and 5.1 kev for  $\text{Mn}^{55}$ . The spacing does not decrease with bombarding energy over the ranges covered in the experiment, 1.42 to 2.47 Mev for  $\text{Mn}^{54}$  and 2.02 to 2.47 Mev for  $\text{Mn}^{55}$ . For the reaction  $\text{Cr}^{53}(\text{p},\text{n})\text{Mn}^{53}$ , the Q-value is  $-1.380 \pm 0.008$  Mev; for  $\text{Cr}^{54}(\text{p},\text{n})\text{Mn}^{54}$ , the Q-value is  $-2.162 \pm 0.005$  Mev. Data are now available to construct a level diagram for the nuclei  $\text{Cr}^{53}$ ,  $\text{Cr}^{54}$ ,  $\text{Mn}^{53}$ , and  $\text{Mn}^{54}$ .

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Columbia Univ.

SUMMARY OF LECTURE DELIVERED TO NORTH-EASTERN SECTION OF THE AMERICAN CHEMICAL SOCIETY ON HIGH ENERGY NUCLEAR REACTIONS; by J. M. Miller. Nov. 7, 1951. 3p. (NYO-814)

This brief summary states that, in order to investigate the hypotheses involved in interactions between nuclei and high-energy particles, the distribution of products resulting from the bombardment of Co and Cu targets with 370-Mev protons in the circulating beam of the Columbia University synchrocyclotron has been examined. Products from Co were found ranging in atomic number from 6 to 28 and in mass number from 11 to 58. The distribution of products within the mass number range 43 to 56 is not inconsistent with the general features of the result of a "Monte Carlo" calculation based on the nucleon-nucleon interaction model. More data are required before the yield of stable isotopes can be inferred and a more detailed comparison with theory made. The formation of very light nuclei, such as  $\text{C}^{11}$  or  $\text{Na}^{24}$ , is probably caused by a process analogous to fission.

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Radiation Lab., Univ. of Calif.

FAST PROTONS FROM 270-MEV N-D SCATTERING (abstract); by W. Hess, J. B. Cladis, and J. Hadley. Oct. 23, 1951. 1p. (UCRL-1519)

The report is reproduced here in its entirety.

The differential cross section for production of high-energy protons in N-D scattering, using the 270-Mev neutron beam of the 184-in. cyclotron, has been measured at scattering angles between 4 and  $58^\circ$ . For normalization, yields of protons from N-P scattering were measured at each scattering angle. In all cases, only protons above a cutoff energy of 200 Mev  $\cos^2 \phi$  were accepted by the counter system. In addition, through the use of a magnetic analyzer, energy distributions of the N-D protons were measured at 4 and

$22.5^\circ$ . The energy distributions closely resembled, in shape, the energy distributions of N-P protons at the same angles, confirming the similarity in nature of collisions of high-energy neutrons with free protons and with protons bound in deuterium. Total yield of protons above the cutoff energy, however, is lower for N-D than for N-P collisions, the ratio of the two being about 0.7 at all angles observed. Effects of the exclusion principle, of the internal momentum distribution of the deuteron, and of the difference in average potential energy between the dineutron and the deuteron will be discussed as possible courses of the lowering of the N-D proton yield below that from N-P scattering.

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Radiation Lab., Univ. of Calif.

ANALYSIS OF NEUTRAL MESON GAMMA RAY SPECTRA FROM CARBON (abstract); by W. E. Crandall, K. Crowe, B. J. Moyer, W. K. H. Panofsky, R. Phillips, and D. Walker. Oct. 23, 1951. 1p. (UCRL-1521)

The report is reproduced here in its entirety.

The  $\gamma$ -ray spectra for angles of observation of 0, 47, 90, 133, and  $180^\circ$  from C targets bombarded by 345-Mev protons have been measured with a multichannel pair spectrometer (Aamodt, Hadley, and Panofsky, *Phys. Rev.* 81, 565 (1951)), and the spectrum obtained by averaging over all angles is compared with the expected spectrum arising from the decay of a neutral pion into two  $\gamma$  rays. Uncertainties in the low-energy portion of the spectrum make a precise assessment of the symmetry properties difficult, but the contribution to the spectrum from nonneutral pion decay radiation does not need to be more than 2% of the observed radiation. If it is assumed that only decay of neutral pions contributes to the radiation observed, then the energy distribution of the neutral pion is derivable from the spectrum. The spectra for lower-energy proton bombardments have been measured for two supplementary angles of view of the target and, based on the observed angular dependence of the spectra for 345-Mev protons, the excitation function for neutral pion production is deduced.

363

Radiation Lab., Univ. of Calif.

ON THE SEMI-EMPIRICAL CORRELATION OF ALPHA DECAY RATES (abstract); by J. O. Rasmussen. Oct. 19, 1951. 1p. (UCRL-1531)

The report is reproduced here in its entirety.

The decay rate data for the even-even type nuclides of the heavy region can be well correlated by a "many body" formula based on the experimental value of the "effective nuclear radius for alpha particles" of  $\text{Th}^{232}$ . The experimental value  $r = 10.27 \times 10^{-13}$  cm was determined by Jungermann (*Phys. Rev.* 79, 640(1950)) from the alpha-induced fission cross section excitation function on  $\text{Th}^{232}$ . The simple decay rate expression used is of the form  $\lambda = fP$  where  $\lambda$  is the decay constant in  $\text{sec}^{-1}$ ,  $f$  is the hypothetical "decay constant without barrier," and  $P$  is the penetration factor, calculated by the WKB approximation. The experimental decay data for 27 different even-even type alpha emitters were used to calculate  $f$ . Excluding only the four nuclides with 126 or less neutrons, the average of  $\log f$  is  $18.84 \pm 0.15$ . It is pointed out that  $f$  is very nearly equal to  $D/h$ , where  $D$  is the average level spacing for the ground states of the alpha emitters as deduced from the energy spacing of alpha fine structure groups.

The orbital electron screening correction to the alpha decay energy is also discussed.

364

Radiation Lab., Univ. of Calif.

INTERPRETATION OF PHOTO-NUCLEAR EXPERIMENTS (abstract); by L. Eyges. Oct. 24, 1951. 1p. (UCRL-1536)



The report is reproduced here in its entirety.

An analysis of the experiments to date on photonuclear reactions suggests the following picture for heavy nuclei ( $Z \gtrsim 50$ ). The emission of particles (mainly neutrons) is governed by the statistical model. The photon total absorption cross section drops off rapidly above about 20 Mev and begins to rise again near the threshold for meson production. In the experiments on total neutron yields with 330 Mev-bremsstrahlung (Terwilliger, Jones, and Jarmie, *Phys. Rev.* **82**, 820 (1951); Kerst and Price, *Phys. Rev.* **79**, 725 (1950)), there are as many neutrons produced by photons with energies above the meson threshold as by photons with lower energies. The integrated total cross sections for  $Z_{84}^{84}$ , Sb, and  $Ta^{181}$  can be evaluated and, by comparison with the Levinger-Bethe formula (*Phys. Rev.* **78**, 115 (1950)), lead to values of 0.5, 0.4, and 0.7, respectively, for the fraction of exchange force in the n-p interaction.

365

MINIMUM GAMMA-GAMMA CROSS SECTION IN GOLD. A. G. W. Cameron and L. Katz. *Phys. Rev.* **84**, 608-9(1951) Nov. 1. (Letter to the editor)

The activation curve for the reaction  $Au^{197}(\gamma, \gamma) Au^{197m}$  has been measured. The minimum cross-section curve has a peak of 5mb at 15 Mev with half width 10 Mev, and the integrated cross section is 0.05 Mev-barns. The ratio of  $(\gamma, \gamma')$  to  $(\gamma, n)$  cross sections has the unexpectedly large minimum value of 0.01, and it is estimated that the decay of the Au nucleus can proceed by initial photon emission in as many as  $\frac{1}{2}$  of the photonuclear excitations. The large  $(\gamma, \gamma')$  to  $(\gamma, n)$  ratio is of the right order of magnitude to result from electric dipole radiation. This lends support to the electric dipole interaction theories at higher excitations.

366

THE INTERACTION IN THE THEORY OF BETA DECAY. D. L. Pursey. *Phil. Mag.* (7) **42**, 1193-1208(1951) Nov.

The cross terms occurring in the expression for the theoretical nth forbidden beta spectrum are given for an arbitrary mixture of interactions. Relations are derived between the six first forbidden vector nuclear matrix elements. Comparison with experiment is made for first forbidden transitions with allowed shape beta spectra. The results are discussed in relation to other recent work in the theory of beta decay. It is concluded that the interaction is most probably tensor with little or no admixture of other interactions. (auth)

367

THE EXCITATION CURVE OF THE  $C^{13}(p, n)N^{13}$  REACTION. C. Eggenberger and P. Marmier. *Helv. Phys. Acta* **24**, No. 4, 323(1951) Sept. 20. (In German)

A measurement by the stacked-foil method of the excitation curve of the  $C^{13}(p, n)N^{13}$  reaction over the proton-energy range 3.23 (threshold) to 6.8 Mev in polythene containing 1.1%  $C^{13}$  is reported briefly. Resonances were found for proton energies of  $4.1 \pm 0.1$ , 4.9, and 6.3 Mev in the laboratory system, corresponding to excitation energies of 11.4, 12.1, and 13.4 Mev for the  $N^{14}$  compound nucleus.

368

THE MASS DIFFERENCE  $Ni^{59}-Co^{59}$ . J. J. G. McCue and W. M. Preston. *Phys. Rev.* **84**, 384(1951) Oct. 15. (Letter to the editor)

Protons from the Rockefeller electrostatic generator have been used to determine the threshold for the  $Co^{59}(p, n)Ni^{59}$  reaction. The  $Co^{59}$  threshold was measured as  $1889 \pm 3$  kev, by comparison with the  $Li^7(p, n)Be^7$  threshold, and the Q value as 1857 kev. When combined with the value  $782 \pm 1$  kev for the n-H mass difference, the present measurement gives  $0.001155 \pm 0.000003$  amu for the mass difference  $Ni^{59}-Co^{59}$ .

369

THE RADIOACTIVE DECAY OF POTASSIUM 40. George Alanson Sawyer. Ph.D. thesis, University of Michigan, 1950.

The following information appears in *Microfilm Abstracts* **10**, No. 4, 268-9(1950).

The  $K^{40}$   $\beta$ -ray activity measured was  $28.3 \pm 1.0$   $\beta$  rays/g ordinary K/sec, which corresponds to a half life from  $K^{40}$  of  $12.2 \pm 0.5 \times 10^8$  yr. The measured  $\gamma$ -ray activity was  $3.6 \pm 0.3$   $\gamma$  rays/g ordinary K/sec or 27  $\gamma$  rays/100  $\beta$  rays. The electron-capture activity was found to be  $13.5 \pm 4.0$  electron captures/100  $\beta$  rays, essentially identical with the number of  $\gamma$  rays, indicating that the  $\gamma$  rays are associated with the electron-capture decay. These decay constants correspond to a total half life for  $K^{40}$  of  $12.7 \pm 0.5 \times 10^8$  yr. A proposed decay scheme is given based on these measurements.

370

NEUTRON EMISSION FROM NUCLEI EXCITED BY HIGH ENERGY PROTONS. D. M. Skyrme and W. S. C. Williams. *Phil. Mag.* (7) **42**, 1187-90(1951) Oct. (Correspondence)

Preliminary report is made of an investigation of evaporation neutrons from C and W targets bombarded with protons of 157 Mev (effective energy) in the Harwell cyclotron. Values were obtained for the differential cross section for neutron evaporation as a function of the kinetic energy of the emitted neutron. The total evaporation cross section of W for neutron energies up to 11 Mev was found to be  $6.0 \pm 0.9$  barns; if certain assumptions are made, the number of neutrons evaporated per excited nucleus is found to be 4. The average number of neutrons evaporated from the C target is less than one per excited nucleus.

371

THE PHOTODISINTEGRATION OF  $^{10}B$  INTO NEUTRON, PROTON, AND TWO  $\alpha$ -PARTICLES. M. J. Brinkworth and E. W. Titterton. *Phil. Mag.* (7) **42**, 1191-2(1951) Oct. (Correspondence)

In the investigation of the reactions  $B^{11}(\gamma, t)2He^4$  and  $B^{10}(\gamma, d)2He^4$  with the  $Li^7(p, \gamma)$  radiation of 14.8 and 17.6 Mev, three-pronged stars have been observed in Ilford E1 boron-loaded emulsions, which fail to give a momentum balance for either of these reactions, or for the reaction  $C^{12}(\gamma, 3\alpha)$ . It appears that at least one neutron is emitted in each of these events. The disintegrations are consistent with the reaction  $B^{10} + h\nu \rightarrow 2He^4 + H^+ + n - 8.07$  Mev. Four possible modes of disintegration which must be considered are listed, but the data are not complete enough for a choice to be made.

372

UNUSUAL BROAD RESONANCES IN  $C^{12}(\gamma, n)C^{11}$  AND  $O^{16}(\gamma, n)O^{15}$ . R. Sagane. *Phys. Rev.* **84**, 587-8(1951) Nov. 1. (Letter to the editor)

Photonuclear resonances in  $C^{12}$  and  $O^{16}$  have been investigated with synchrotron-produced x radiation with an upper limit adjustable to 70 Mev. The induced radioactivity of  $Cu^{62}$  was used as a monitor. The  $C^{12}$  and  $O^{16}$  resonances are quite similar, each being markedly asymmetrical and exhibiting a prominent high-energy tail which extends to over 60 Mev.

373

COMPUTATION OF PHOTONUCLEAR RESONANCE CURVES FROM RELATIVE ACTIVITY CURVES MONITORED BY INDUCED RADIOACTIVITY. R. Sagane. *Phys. Rev.* **84**, 586-7(1951) Nov. 1. (Letter to the editor)

A method is described for obtaining photonuclear cross sections from observed bremsstrahlung activation curves by monitoring with induced radioactivity. The use of a monitor radioactivity, in effect, serves to normalize the bremsstrahlung spectra in terms of the area under the  $\sigma_M \times N_{hv}$  (cross section times number of quanta) curves.

The procedure is illustrated graphically for the reaction  $C^{12}(\gamma, n)C^{11}$  monitored by the radioactivity induced in Cu.

374

ANGULAR CORRELATION IN NUCLEAR RESONANCE REACTIONS. K. A. Ter-Martirosyan. *Zhur. Eksptl'. i Teoret. Fiz.* 21, No. 8, 894-9(1951) Aug. (In Russian)

The author derives, without the use of perturbation theory, general formulas for the angular correlation of particles formed in nuclear resonance reactions and for the angular correlation of particles emitted successively by the nucleus. The case where one of the particles is a  $\gamma$  quantum is considered.

375

THE LONG-RANGE TRITONS FROM THE REACTION  $^9\text{Be}(d, t)^8\text{Be}$ . F. A. El-Bedewi. *Proc. Phys. Soc. (London)* 64A, 947-8(1951) Oct. (Letter to the editor)

The emission of tritons as a result of deuteron bombardment of  $\text{Be}^9$  was investigated by photographic methods. The range distribution of tritons from the ground-state transition of the reaction  $\text{Be}^9(d, t)\text{Be}^8$  was plotted for angles 20 and 40°. The angular distribution in the center-of-mass system was also plotted for angles from 20 to 75°. Using the range-energy curve the mean energy of the triton group was found. The mean Q-value calculated for the different angles was  $4.67 \pm 0.03$  Mev.

376

THE EXCITATION FUNCTION FOR THE PRODUCTION OF  $^7\text{Be}$  BY THE BOMBARDMENT OF  $^{12}\text{C}$  BY PROTONS. J. M. Dickson and T. C. Randle. *Proc. Phys. Soc. (London)* 64A, 902-5(1951) Oct.

The excitation function for the production of  $\text{Be}^7$  from  $\text{C}^{12}$  has been determined by an activation method, using the internal proton beam of the 110-in. Harwell cyclotron. The threshold energy has been found to be 32 Mev and the cross section at 156 Mev is  $11.0 \pm 1.3 \times 10^{-27}$  cm<sup>2</sup>.

#### PARTICLE ACCELERATORS

377

Massachusetts Inst. of Tech. Research Lab. of Electronics DETERMINATION OF AXIAL FIELD STRENGTH IN A LINEAR ACCELERATOR CAVITY (Technical Report No. 205); by L. C. Maier, Jr., and J. C. Slater. May 31, 1951. 6p. (NP-3470)

One theoretical and two experimental methods are described for finding the accelerating field in the M.I.T. linear accelerator cavity in terms of the input power. One of the experimental methods is based on measuring the power leaking out through a calibrated hole in an end wall closing the cavity, with the hole located where the field strength is to be determined. The other method is based on the perturbation of the resonant frequency of the cavity by a small conducting sphere located on the axis. All three methods of determination check satisfactorily. In terms of the resulting relations, the probable field actually existing in the accelerator under operating conditions is discussed. (auth)

378

Radiation Lab., Univ. of Calif. SOME DIFFERENTIAL ANALYZER METHODS FOR ORBIT PROBLEMS IN THE CYCLOTRON (abstract); by Bayard Rankin, John Killeen, and Walter H. Barkas. Oct. 1951. 1p. (UCRL-1539)

The report is reproduced here in its entirety.

The equations of motion for a charged particle in a magnetic field have been solved previously in some special cases (Coggeshall and Muskat, *Phys. Rev.* 66, 187 (1944) and Barkas, *Phys. Rev.* 78, 90 (1950)). These solutions almost always lead to numerical methods. However, the median and vertical-plane motion for any axially symmetric field can be obtained quickly on a differential analyzer after transforming the equations by a few simple devices. Only resets on

the integrands are required for each set of initial conditions, and an orbit can be drawn every 5 min. The horizontal motion is solvable on an analyzer of six integrators and three input tables. It is necessary simply to introduce the variable  $\lambda = \phi + (eH/mc)$  in the equation  $\dot{r} = r \dot{\phi} d[\int \lambda dt]$  and effect a transformation which leaves the relativistic mass independent of the initial conditions without changing the momentum. The vertical motion is handled similarly but demands more integrators. An approximation to the vector potential is necessary. Of special interest are the paths of 30- to 100-Mev  $\pi$  mesons which are produced in a target at a radius of 80 in. in the 184-in. cyclotron, 200 of these having been obtained on a selsyn-driven analyzer by using the methods described. Various focusing points have been examined at seven different energies.

379

Radiation Lab., Univ. of Calif. ACCELERATION OF MULTIPLY CHARGED NUCLEI (abstract); by Cornelius A. Tobias. Oct. 1951. 1p. (UCRL-1541)

The report is reproduced here in its entirety.

A method is proposed for cyclotron acceleration of nuclei  $zA$  to high energies without limitation in their atomic number  $Z$ . A low-voltage external ion source is used in which an intense beam of ions with low multiplicity of charge, e.g.,  $zA^{(++)}$ , is made. These ions are "preaccelerated" in a linear accelerator to a velocity which is somewhat higher than the velocity of the K electrons of  $zA$ . Only those ions remain usable which retain their charge  $(++)$  during the entire preacceleration, without electron exchange. If the gas pressure of the accelerator is low enough a large fraction of  $zA^{(++)}$  is retained and can be injected in a frequency-modulated cyclotron tangentially to a cyclotron orbit for  $zA^{(Z+)}$ . When the cyclotron orbit is reached, the ions  $zA^{(++)}$  are passed through the edge of a thin metal foil which strips them of all their electrons, forming  $zA^{(Z+)}$ . If the ions arrive in proper phase, they will be accelerated in the cyclotron without much further loss due to electron exchange. A similar preaccelerator can be used for tangential injection of the stripped ions  $zA^{(Z+)}$  in the bevatron.

380

A FREQUENCY MODULATED ACCELERATING SYSTEM FOR A RACETRACK SYNCHROTRON. John Stanley Malik. Ph.D. Thesis, Univ. of Michigan, 1950.

The following information appears in *Microfilm Abstracts* 10, No. 3, 188-9(1950).

The construction of the frequency-modulated accelerating system is given for the University of Michigan synchrotron. The curve of frequency vs. time for arbitrary field is developed, and for a linear rate of rise it is shown that it may be approximated with sufficient accuracy with a single exponential. Several methods of producing the required modulation are reviewed, and the design of the two most promising are discussed. The first of these is that of generating the required curve at low levels by beating together two klystrons and amplifying this signal in a series of wide-band amplifier stages, the output of which is applied to a toroidal cavity. The other method, which is the one used for the present machine, uses a drift tube driven by a variable-frequency oscillator. The variable element is an inductor using a powdered iron core which is placed in one of two gaps of a laminated pulse core which in turn is placed between the poles of a d-c electromagnet. The electromagnet supplies bias flux to nearly saturate the powdered iron core, setting the maximum frequency limit. Pulse windings on the laminated core are used to tip this constant flux between the two gaps to produce the required frequency curve. The equipment and circuits required together with the monitoring equipment are given.



## RADIATION ABSORPTION AND SCATTERING

381

Argonne National Lab.

COHERENT NEUTRON-PROTON SCATTERING BY LIQUID MIRROR REFLECTION; by G. R. Ringo, M. T. Burgy, and D. J. Hughes. Aug. 16, 1951. 19p. (AECU-1675; UAC-437)

An abstract of this report was issued as report AECU-1048 and appears in its entirety in Nuclear Science Abstracts as NSA 5-2599.

382

Nuclear Physics Lab., Case Inst. of Tech.

DIFFUSION OF HIGH ENERGY GAMMA RAYS THROUGH MATTER; III. REFINEMENT OF THE SOLUTION OF THE DIFFUSION EQUATION (Technical Report No. 6); by L. L. Foldy. Jan. 29, 1951. 20p. (AECU-1709)

A similar article was published in Phys. Rev. **82**, 927-31 (1951) June 15, and abstracted in Nuclear Science Abstracts as NSA 5-4893.

383

Brookhaven National Lab. and Smith Coll.

SUMMARY CALCULATIONS FOR PROJECTED MULTIPLE SCATTERING; by William T. Scott. Sept. 12, 1951. 14p. (BNL-1003)

The multiple-scattering theories of Molière and Snyder-Scott are compared, and the equivalence of the mathematical development is pointed out. Several formulas for mean-value quantities are given: mean arithmetic angle, half-width,  $1/e$  width, angle  $1/P_0 \pi^{1/2}$  related to the zero-angle amplitude, and mean arithmetic angle with a cutoff at 4 times the mean. These quantities are given for both the projected tangent angle and projected chord angle distributions, in the form of linear relationships between the square of the angle divided by  $\Omega$  and the logarithm of  $\Omega$ , where  $\Omega$  is the mean number of scatterings undergone by the particle in question. The linear relationships are good to 1% for  $\Omega$  from  $10^2$  to  $10^5$ . Information is also given on smoothed-out distributions, and on an estimate of the error for the cut-off arithmetic mean angle. The scattering constant  $K$  is given for several methods of measurement, for Ilford G-5 emulsions. (auth)

384

Nuclear Development Associates, Inc.

ASYMPTOTIC SOLUTIONS FOR THE STRAIGHT AHEAD TRANSPORT EQUATION; by J. Ernest Wilkins, Jr., Alan Oppenheim, and Stanley Preiser. Oct. 15, 1951. 52p. (NYO-639)

Asymptotic expansions of the solutions for the straight-ahead transport equation are derived, when the scattering kernel is separable and the total cross section is either monotonic, parabolic, or arbitrary with an absolute minimum. The answers for the monotonic and parabolic total cross section are generalizations and extensions of results given by Fano, Welton, and Hurwitz for specific kernels. In addition the asymptotic expansion for an arbitrary kernel and a constant total cross section is derived. A few numerical examples are discussed and some of them are compared with answers obtained from Greuling-type solutions of the straight-ahead transport equation reported in NYO-633, NYO-634, and NYO-635. (auth)

385

Rochester Univ.

PROTON-PROTON SCATTERING AT 240 MEV BY A MAGNETIC DEFLECTION METHOD; by Oscar A. Towler, Jr. Oct. 19, 1951. 5p. (NYO-3030)

Proton-proton scattering at 240 Mev has been observed for eight angles ranging from  $171.3$  to  $108.1^\circ$  center of mass. The cross section has the previously observed isotropic behavior down to about  $15^\circ$  and then increases sharply by a

factor of 3.5 at  $8.7^\circ$ . This increase at the small c.m. angle, due in part to Coulomb effects, has the same general trend observed by Chamberlain, Segrè, and Wiegand (Phys. Rev. **83**, 923(1951)) at  $11.3^\circ$  for 345-Mev protons. The average value of the cross section (excluding the value at  $8.7^\circ$ ) is  $4.66 \pm 0.39$  mb/ster., based on a  $C^{12}(p,pn)C^{11}$  cross section of  $49 \pm 3$  mb. The error in the average value includes the statistical error, the 6% error in the  $C^{11}$  cross section, a 4% error in the beta-counter calibration, and other estimated errors. (auth)

386

Radiation Lab., Univ. of Calif.

DETECTION OF THE AZIMUTHAL POLARIZATION OF THE NEUTRON-PROTON INTERACTION IN THE 150-MEV ENERGY REGION (thesis); by Louis Wouters. Sept. 18, 1951. 61p. (UCRL-1470)

Spin-dependent effects in n-p interaction were studied in a double scattering experiment using an initially unpolarized beam and unpolarized targets. A small part of the flux scattered and partly polarized by the first n-p interaction was used as the incident flux in the second n-p interaction. The azimuthal dependence of the second-scattered flux was measured at various given scattering angles by means of an azimuthal array of particle detectors. The results are interpreted as a direct confirmation of the existence of noncentral nucleon-nucleon interaction in the 150-Mev energy region.

387

Radiation Lab., Univ. of Calif.

POLARIZATION EFFECTS IN n-p SCATTERING; by Don R. Swanson. Sept. 26, 1951. 7p. (UCRL-1487)

The expected azimuthal asymmetry in a double scattering of high-energy neutrons by protons has been calculated using the "half exchange" n-p interaction of Christian and Hart (Phys. Rev. **77**, 441). The calculations were carried out using the phase shifts of Christian and Hart in the  $^3S_1$ ,  $^3D_1$ ,  $^3D_2$ , and  $^3D_3$  states, with all higher included in the Born approximation. The polarization is plotted as a function of scattering angle for a single n-p collision at laboratory energies of 40, 90, 200, and 285 Mev. Detection of azimuthal asymmetry at  $\pi/2$  would indicate the presence of both odd and even terms and disprove the "even" exchange hypothesis. For energies of 220 and 160 Mev for the two scatterings, respectively, the ratio of intensities at angles of 0 and  $\pi$  is calculated as  $1.12 \pm 0.03$  for one case. An experiment in which the asymmetry agreed in sign and order of magnitude with the calculations is mentioned.

388

Radiation Lab., Univ. of Calif.

INTERNAL MOMENTUM DISTRIBUTIONS FROM SCATTERING EXPERIMENTS (abstract); by J. B. Cladis, W. Hess, and B. J. Moyer. Oct. 23, 1951. 1p. (UCRL-1520)

The report is reproduced here in its entirety.

The mean free path in nuclear material and the de Broglie wavelength of a 340-Mev proton are such that a single collision with a nucleon of a light nucleus is expected when the proton is scattered. Thus, at scattering angles greater than about  $25^\circ$ , where interference terms are small, the proton energy spectra reflect the momentum distribution of the nucleons in the target nucleus. An expression for the spectra as a function of momentum distribution and scattering angle has been given by Wolff (UCRL 1410).

Energy spectra of protons scattered from H, D, and C have been obtained at scattering angles of  $30$  and  $40^\circ$ . These spectra are obtained by deflecting the protons by a magnetic field into channels defined by proportional counters and a bank of 35 Geiger counters. Spectra calculated by

inserting the theoretical momentum distribution for the deuteron and the gaussian distribution (Henley and Huddleston, *Phys. Rev.* **82**, 754 (1951)) for carbon into Wolff's formulas fit the data fairly well at both angles. The Chew-Goldberger distribution contains too many high-momentum components.

389

Radiation Lab., Univ. of Calif.

NUCLEAR MOMENTUM DISTRIBUTIONS (abstract); by Peter A. Wolff. Oct. 24, 1951. 1p. (UCRL-1524)

The report is reproduced here in its entirety.

Using the impulse approximation, a formula has been obtained which gives the energy distributions, at several angles, of fast protons that have been scattered from nuclei. The formula involves an integral over the nuclear momentum distribution and can, therefore, be used to extract information about this distribution from experimental data on scattering. The fitting of the experimental curves is most sensitive to the high momentum components in the nuclear wave function; in particular, it will be shown that long-tailed momentum distributions such as that proposed by Chew and Goldberger (*Phys. Rev.* **77**, 470 (1950)) are not suitable, whereas a gaussian with average energy of about 25 Mev fits the data well at several angles of scattering. The final theoretical energy distributions contain corrections, calculated by the Monte Carlo method, for the effects of multiple scattering of the proton within the nucleus. These distributions will be compared with those obtained by Cladis experimentally and a discussion will be given of the error inherent in the method, which is estimated to be about 5% for protons of 340 Mev.

390

Radiation Lab., Univ. of Calif.

HIGH ENERGY ELECTRON-ELECTRON SCATTERING (abstract); by Charles E. Violet, F. C. Gilbert, Robert W. Deutsch, and Walter H. Barkas. Oct. 24, 1951. 1p. (UCRL-1527)

The report is reproduced here in its entirety.

Eradicated electron-sensitive nuclear emulsions were exposed to 200-Mev electrons obtained by magnetic analysis of pairs converted in the synchrotron beam. By following primary electron tracks in the emulsion, 427 electron-electron scattering events were recorded in which the scattered electron of lower energy, or knock-on electron, had an energy greater than 30 kev. The knock-on energy was determined by measuring either the range or the angle between the knock-on and primary tracks. The observed absolute differential cross section, as a function of knock-on energy, was found to be consistent with Møller's theoretical cross section. At this primary energy, a sufficient number of events of large fractional energy transfer could not be observed to detect exchange, spin, and retardation effects, and actually only the classical relativistic theory was verified. Two pairs initiated by primary electrons and two cases in which primary electrons vanished in the emulsion were also observed in 102.6 cm of track. No heavy particle events were observed.

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OBSERVATIONS ON THE MULTIPLE SCATTERING OF IONIZING PARTICLES IN PHOTOGRAPHIC EMULSIONS. PART IV. PROTONS OF 336 MEV FROM THE BERKELEY CYCLOTRON. COSMIC RAY PROTONS AND MESONS OF 5 TO 50 MEV. K. Gottstein and J. H. Mulvey. *Phil. Mag.* (7) **42**, 1089-96(1951) Oct.

Ilford G5 emulsions were dropped through the proton beam of the 184-in. Berkeley cyclotron. Scattering measurements were made and second differences obtained for various cell sizes. These measurements were then used to

calculate the scattering constant. An account is given of an experimental determination of the relation between the scattering parameter and residual range for protons and mesons of the cosmic radiation. A second value of the scattering constant was found, using the range and energy of  $\mu$  mesons from the decay of  $\pi$  mesons stopping in the emulsion. The result was used to obtain a range-energy relation for protons of energy up to 200 Mev.

392

THE WAVELENGTH OF THE X RADIATION AT A DEPTH IN WATER IRRADIATED BY BEAMS OF X RAYS. J. R. Greening and C. W. Wilson. *Brit. J. Radiology* **24**, 605-12 (1951) Nov.

A description is given of some measurements of the effective wavelength of the total and primary radiation reaching depths down to 15 cm in a water phantom irradiated by beams of x rays. The effective wavelengths are determined by measuring the ratio of the ionizations in an "air-equivalent" and an aluminum-lined chamber using a modified Kemp comparator, for which a new method of calibration is described. From these measurements the wavelength of the scattered radiation is deduced and qualitative explanations of the phenomena observed are offered. The significance of the results for the conversion of doses measured in r to doses measured in ergs/g is pointed out and some applications to the case of bone are given.

393

FLUCTUATIONS IN THE ENERGY-LOSS OF FAST ELECTRONS IN A PROPORTIONAL COUNTER. P. Rothwell. *Proc. Phys. Soc. (London)* **64B**, 911-15(1951) Oct.

The fluctuations in the energy lost by fast electrons over a fixed small fraction of their range have been studied by measuring the pulses the electrons produce in passing through a proportional counter. The energy loss distribution calculated theoretically by Landau is approximately gaussian with a high-energy tail. The experimental distribution is in agreement with the theoretical on the high-energy side of the peak, but is wider than Landau predicts on the low-energy side; this discrepancy is greater in krypton than in argon. The experimental values of the most probable energy loss agree with the theoretical values. (auth)

394

TOTAL CHARGES OF FISSION FRAGMENTS AS FUNCTION OF THE PRESSURE OF THE STOPPING GAS. N. O. Lassen. *Kgl. Danske Videnskab. Selskab, Mat.-fys. Medd.* **26**, No. 12, 4-19(1951)

The total charge of fission fragments was measured as a function of the pressure of the stopping gas. The peak deflection distribution for pressure 0 to 400 mm in Hg and He shows the following results: the position of the peak is independent of the minimum pulse size counted, the fragment pulses are clearly separated from the background pulses, the initial charge is approximately proportional to the deflection, and with increased pressures the charges of the light fragments seem to approach the values 18e and 19e. Similar results were obtained for A but at reduced pressures.

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COMPARATIVE INVESTIGATION OF ABSORPTION OF MONOCHROMATIC POSITRONS AND ELECTRONS.

K. A. Baskova and B. S. Dzhelepov. *Doklady Akad. Nauk S.S.S.R.* **77**, No. 6, 1001-2(1951) Apr. 21. (In Russian)

The ratio of  $\beta^+$  to  $\beta^-$  absorption in Pb for particles of energies 0.260 to 2.44 Mev is shown graphically. The electron emitters RaE ( $\text{Bi}^{210}$ ), RaB + C + C' ( $\text{Pb}^{214}$ ,  $\text{Bi}^{214}$ ,  $\text{Tl}^{210}$ ), and  $\text{Cu}^{64}$  and the positron emitters  $\text{Cu}^{61}$ ,  $\text{P}^{30}$ ,  $\text{Co}^{56, 57, 58}$ , and  $\text{Cu}^{64}$  were used in this experiment.



396

AVERAGE EXCITATION POTENTIALS OF AIR AND ALUMINIUM. M. Bogaardt and B. Koudijs. *Physica* 17, 703-10(1951) July.

By means of a graphical method the average excitation potential  $I$  may be derived from experimental data. Average values for  $I_{\text{air}}$  and  $I_{\text{Al}}$  have been obtained. It is shown that in representing range/energy relations by means of Bethe's well-known formula (Revs. Modern Phys. 9, 245-390(1951)),  $I$  has to be taken as a continuously changing function of the energy of the incident particle. (auth)

397

DETERMINATION OF THE RANGE-ENERGY CURVE OF LITHIUM IN NUCLEAR EMULSIONS. Pierre Cüer and Jean-Pierre Lonchamp. *Compt. rend.* 233, 939-41(1951) Oct. 22. (In French)

Range-energy curves in emulsion are shown for  $\text{Li}^6$ ,  $\text{Li}^7$ , and  $\text{Li}^8$  in the range 0 to 12 Mev, the nuclides being assumed initially bare, i.e., triply charged. These were calculated by considering the statistical mechanism of electron capture by ions of charge 2 and 3 and by extrapolation from known absorption data. Details of the calculations are not given.

398

ON THE MULTIPLE SCATTERING OF CHARGED PARTICLES. Robert Mertens. *Compt. rend.* 233, 856-8(1951) Oct. 15. (In French)

A formula for the angular distribution of charged particles traversing a metal foil is derived from the fundamental integro-differential equation.

399

RANGE-ENERGY RELATION OF PROTONS IN ILFORD C2 EMULSION. NEW EXPERIMENTAL CONFIRMATIONS OF A PREVIOUS CALCULATION. Léopold Vigneron and Maarten Bogaardt. *Compt. rend.* 233, 941-3(1951) Oct. 22. (In French)

Ranges in Ilford C2 emulsion of 0.2- to 8.2-Mev protons have been calculated by a method previously described (Bogaardt and Vigneron, *J. phys. radium* 11, 652(1950); NSA 5-1062) and are tabulated. Comparison with recently published experimental data indicates that the method may be applied with high validity to at least 8 Mev.

400

THE SMALL-ANGLE SCATTERING OF X-RAYS BY NITROGEN. Robert Lee Wild. Ph.D. thesis, University of Missouri, 1950.

The following information appears in *Microfilm Abstracts* 10, No. 4, 272-3(1950).

A single-crystal x-ray spectrometer with a Geiger counter as the detecting device has been used to measure the small-angle scattering from N in the general region of the critical point. The change in small-angle scattering at a fixed angle was investigated as the conditions of the experimental sample approached the liquid-vapor transition. Values of isothermal compressibility were calculated from x-ray data for several combinations of temperature and pressure along both sides of the saturated vapor curve.

401

THE NUCLEAR SCATTERING OF ELECTRONS AND POSITRONS IN ARGON. A. F. Howatson and J. R. Atkinson. *Phil. Mag.* (7) 42, 1136-45(1951) Oct.

An automatic Wilson cloud chamber with specially constructed cameras was used to obtain data on the nuclear scattering in argon of electrons from  $\text{In}^{114}$  and positrons from  $\text{Cu}^{62}$ . The tracks were analyzed by the method of projected angles. The experimental angular-scattering distribution was compared with calculated values based on Dirac's relativistic electron theory, the ratio experiment/theory of scattering events over the angular range 20 to 90° being 1.02 for electrons and 0.92 for positrons. Similar calculations based on the semiclassical Rutherford scattering for-

mula gave for the positron case a ratio experiment/theory of 0.79. This is regarded as evidence in favor of the Dirac theory, which gives a smaller scattering cross section for positrons than for electrons. (auth)

402

DEPENDENCE ON Z OF THE REACTION CROSS SECTION FOR PAIR PRODUCTION BY  $\text{Ra } \gamma$  RADIATION. B. Hahn, E. Baldinger, and P. Huber. *Helv. Phys. Acta* 24, No. 4, 324-5(1951) Sept. 20. (In German)

The ratio of pair-formation cross section to  $Z^2$  has been determined experimentally for  $\text{Ra } \gamma$  radiation (principal lines 1.76 and 2.20 Mev) and is plotted as a function of  $Z$  for the elements Fe, Ni, Cu, As, Cd, Sn, Ta, Pb, Bi, and U. The validities of several approximations are considered in relation to these values. Two-quantum Compton effects, one-quantum annihilation radiation, and triplet formation are considered negligible.

## RADIATION EFFECTS

403

Old and Barnes, Inc.

A SIMPLE FLASH X-RAY CIRCUIT; FOURTH REPORT ON MISCELLANEOUS EFFECTS; OCTOBER 1950 - MARCH 1951; by R. O. Fleming, Jr. Issued Mar. 23, 1951. 26p. (NP-3480; U-17300; Memo Report No. 16)

The production of soft x rays in the region from 5.6 to 27.0 Å in a specially designed x-ray tube and their detection by means of different phosphors in a scintillation counter is described. The phosphor was shielded from exciting agents other than x rays by various thicknesses of Al foil and by grids inserted between the anode of the x-ray tube and the phosphor. Good voltage regulation was found necessary for satisfactory operation, so three d-c power supplies have been designed and built. These power supplies are described. The process developed for producing thin films of a phosphor on a lucite base is described, as well as the process developed for aluminizing the face of the phosphor to protect it from extraneous light, and the precautions taken to assure that exciting agents other than the x rays do not reach it. Results obtained using Al and Cu targets for all phosphors used are reported. Cadmium tungstate has given the best results. The aluminum K line at 8.32 Å has been observed. The absorption of x rays by the Al film shielding the phosphor has been studied and the results seem to confirm the theoretical work of Siegbahn. The production of x-ray photons by a target is supposed to be proportional to the atomic weight of the element composing it. This ratio has been checked for Al vs. Cu and the results seem to confirm the rule for x-ray-tube anode voltages below 700 v.

404

PHOTOGRAPHS OF THE SECONDARY ELECTRONIC EMISSION DUE TO THE GAMMA RAYS OF RADIUM. D. K. Bewley. *Brit. J. Radiology* 24, 521-2(1951) Sept.

The photographs shown were taken by laying various materials on the emulsion side of Kodak line film, and exposing to  $\gamma$  rays in a black box. The various degrees of photographic blackening give a direct demonstration of the shape of the curve connecting the forward emission of electrons due to the  $\gamma$  rays of radium and the atomic number of the substance used as the secondary emitter. They also indicate the variation of ionization at various depths in tissue-like material.

## RADIOACTIVITY

405

Argonne National Lab.

ALPHAS AND GAMMAS FROM THE PROTON BOMBARDMENT OF  $\text{Be}^9$ ; by D. R. Inglis and R. E. Malm. Aug. 1951. 3p. (AECU-1717; UAC-449)

Preliminary observations have been made of the  $\alpha$  and  $\gamma$  radiation from proton bombardment of a  $\text{Be}^9$  target. Two  $\alpha$  groups corresponding to the ground state and the 2.19-Mev excited state of  $\text{Li}^6$  were observed. The varying yield of product particles, observed in a proportional counter, as the magnetic field was varied is shown. The peaks correspond to both  $\alpha$  groups and to protons scattered elastically from Be, C, and O. The proton energy was varied through a small range near the expected resonance, and the resonance was observed for the  $\gamma$  but not for either  $\alpha$  group. This means that the resonant  $\gamma$ 's are not associated with the 2.19-Mev state of  $\text{Li}^6$ .

406

Brookhaven National Lab.  
NOMOGRAM FOR CALCULATING FISSION PRODUCT ACTIVITIES; by L. G. Stang, Jr., and Paul D. Hance, III. [nd] 7p. (BNL-1015)

The equation relating the activity of a fission product to the flux, the time of irradiation, the fission yield, the half life of the fission product, and the amount of U used is derived. It is also shown how this equation relates to the three scales of the nomogram. The three scales give the activity of a particular fission product (measured in curies/g of U), per cent fission yield, and irradiation time ( $T/\tau$  half lives where  $T$  = time and  $\tau$  = half life of fission product). Any one of the values may be found whenever the other two are known.

407

Laboratory for Nuclear Science and Engineering, Mass. Inst. of Tech.  
QUARTERLY PROGRESS REPORT; JANUARY-MARCH 1951; NEUTRON AND GAMMA-RAY SHIELDING GROUP AND ELECTRONIC NUCLEAR INSTRUMENTATION GROUP; G. A. Norton, ed; Laboratory for Nuclear Science and Engineering, Mass. Inst. of Tech. and Servomechanisms Lab., Mass. Inst. of Tech. [nd] 48p. (NP-3493)

The excitation of (p,n) reactions in  $\text{C}^{14}$ ,  $\text{Cl}^{37}$ ,  $\text{Cr}^{53}$ ,  $\text{Cr}^{54}$ , and  $\text{Mn}^{55}$  has been examined. Graphs show neutron yield vs. proton energy for the five mentioned isotopes. The total neutron cross section of liquid  $\text{N}^{14}$  was measured in the energy range 0.2 to 1.6 Mev. The excitation curve of metastable  $\text{Cd}^{111}$  under neutron bombardment is shown. The Beckman MX3A radiation monitor has been tested and appears to have linear response over sufficient input voltage to operate satisfactorily as a low-grid-current, direct-voltage vacuum-tube voltmeter. A method of calibrating the L.N.S.E. ten-channel pulse-height analyzer is given. A photograph shows the magnet control console for the Rockefeller generator.

408

Rochester Univ.  
THE  $\beta$  DECAY OF RADIUM E AND THE SHELL MODEL; by A. G. Petschek and R. E. Marshak. Oct. 24, 1951. 7p. (NYO-3032)

The linear combination of tensor and pseudoscalar interactions corresponding to  $I = 13 \pm 1$ , can be regarded as giving a satisfactory fit of the RaE spectrum. Moreover, it is the only linear combination which can explain the forbidden shape of the RaE spectrum if the parity prediction of the shell model is accepted. The results provide the first clear-cut evidence for the inability of the pure tensor interaction to explain all  $\beta$ -ray phenomena. It is evident that the 0-0, yes transition which is indicated for RaE cannot decide whether the S or V interaction must also be added to the (TP) combination.

409

Oak Ridge National Lab.  
AN INVESTIGATION OF X-RAY AND GAMMA RAY

SPECTRA OF SHORT PERIOD RADIOISOTOPES; by Jack H. Kahn. Issued Nov. 8, 1951. 90p. (ORNL-1089)

The principles of nuclear isomerism and internal conversion are discussed in general, as are methods for detection of  $\gamma$  rays. Proportional counters and scintillation spectrometers are discussed in more detail. The latter two were used in a search for new short-period nuclear isomers. A short-period neutron-induced  $\gamma$  activity was discovered in Pd ( $E = 173$  kev,  $\tau = 5$  min), In ( $E = 153$  kev,  $\tau = 2.5$  sec) and Yb ( $E = 455$  kev,  $\tau < 0.5$  sec). Two  $\gamma$  rays ( $E = 59$  and 74 kev) were found to be associated with the 3.5-min  $\text{Sb}^{122}$  activity, previously reported to emit only one  $\gamma$  ray. Other transition energies were measured as follows: 10.7-min  $\text{Co}^{60}$ , 58.5 kev; 17.5-sec  $\text{Se}^{77}$ , 130 Kev; 6.6-min  $\text{Nb}^{94}$ , 41.5 kev; 4.7-min  $\text{Rh}^{104}$ , 51.5 kev; 39-sec  $\text{Ag}^{109}$ , 87 kev; 1.3-min  $\text{Dy}^{165}$ , 102 kev; 6-sec Yb, 212 kev; 19-sec  $\text{Hf}^{179}$ , 161 kev; 5.5-sec  $\text{W}^{183}$ , ~80 kev; and 1.5-min  $\text{Ir}^{192}$ , 57.4 kev. The fluorescent yield for the K shell of Kr (0.70) and Xe (0.85) was measured. The efficiency of a xenon-methane filled proportional counter as a function of energy of the incident electromagnetic radiation was determined. Partial internal-conversion coefficients are tabulated for  $\text{Co}^{60}$  ( $\alpha_K = 35$ ),  $\text{Nb}^{94}$  ( $\alpha_K > 100$ ),  $\text{Ir}^{192}$  ( $\alpha_L > 400$ ), and  $\text{U}^{239}$  ( $\alpha_L = 0.2$ ).

410

Radiation Lab., Univ. of Calif.  
ALPHA RADIOACTIVITY IN THE MEDIUM HEAVY ELEMENTS; by J. O. Rasmussen, S. G. Thompson, and A. Ghiorso. Sept. 20, 1951. 81p. (UCRL-1473)

In a survey for  $\alpha$  activity among cyclotron-produced neutron-deficient nuclides of the medium heavy elements  $\alpha$  activity was found in a number of rare earth nuclides with atomic number greater than 62 (Sm) and in a Au and a Hg nuclide. The experimental results of studies of the various  $\alpha$  activities discovered in this investigation are presented. Experimental values of  $\alpha$  decay rates are compared with calculations from four different  $\alpha$  decay rate formulas. The trends of the rare earth  $\alpha$  decay energies are noted and their interpretation as a consequence of a decrease in neutron binding energies just beyond the closed shell of 82 neutrons proposed. (auth)

411

Radiation Lab., Univ. of Calif.  
SOME SHORT-LIVED ALPHA EMITTERS IN THE NEIGHBORHOOD OF POLONIUM 211 (thesis); by Fred Noel Spiess. Oct. 8, 1951. 70p. (UCRL-1494)

Three short-lived  $\alpha$  emitters resulting from  $\alpha$ -particle bombardment of Pb have been studied. They have been identified as  $\text{Bi}^{211}$  ( $T_{1/2} = 2.16$  min) and two states of  $\text{Po}^{211}$  ( $T_{1/2} = 25$  and 0.52 sec) by means of chemical separation, excitation functions, half-life measurements, and measurements of the energies of the emitted  $\alpha$  particles. The half life of  $\text{Po}^{211}$  as it occurs following the K-capture decay of  $\text{At}^{211}$  has been measured for the first time, and is 0.52 sec rather than the  $5 \times 10^{-3}$  sec widely quoted in the literature. The energy measurements indicate that the 0.52-sec state is the upper state of  $\text{Po}^{211}$ , with an excitation energy of about 0.3 Mev. A group of  $\alpha$  particles of about 9-Mev energy has been observed but not identified further. (auth)

412

Radiation Lab., Univ. of Calif.  
ALPHA RADIOACTIVITY IN ELEMENTS BELOW LEAD (abstract); by S. G. Thompson, J. O. Rasmussen, and A. Ghiorso. Oct. 19, 1951. 1p. (UCRL-1515)

The report is reproduced here in its entirety.

In a continuation of the survey for alpha activity among cyclotron-produced, neutron-deficient isotopes of the medium heavy elements, alpha activity was found in a number



of rare-earth nuclides with atomic number greater than 62 (samarium). Element assignments were usually made by chemical separations and the mass numbers of several were assigned either by mass spectrographic determination or by means of excitation functions. Alpha radioactivity due to traces of heavy element ( $Z > 82$ ) contamination even in the purest samples was nearly always produced, and discrimination by means of alpha energy determination or by chemical separations was necessary. Alpha energies in the rare earths ranged from 2.7 Mev in long-lived  $\text{Gd}^{150}$  to 4.2 Mev in a 7-min dysprosium isotope. The alpha-emitting rare-earth isotopes are of neutron number 84 or greater and their instability toward alpha decay is interpreted as being due to the influence of 82 neutrons.

413

Radiation Lab., Univ. of Calif.

**L X-RAYS AND LOW ENERGY GAMMA RADIATION IN THE DECAY OF  $\text{Am}^{241}$**  (abstract); by C. I. Browne and I. Perlman. Oct. 19, 1951. 1p. (UCRL-1516)

The report is reproduced here in its entirety.

The L x rays and low energy gamma rays given off following the alpha decay of  $\text{Am}^{241}$  have been studied on a 10-in. bent crystal x-ray spectrometer. Eight gamma rays have been observed in the spectral region 12-85 kev, with energies ranging from  $14.23 \pm 0.06$  to  $59.78 \pm 0.02$  kev. The  $\text{La}_2$ ,  $\text{La}_1$ ,  $\text{Ln}$ ,  $\text{L}\beta_2$ ,  $\text{L}\beta_4$ ,  $\text{L}\beta_1$ ,  $\text{L}\gamma_1$ , and  $\text{L}\gamma_6$  x rays of neptunium from gamma-ray internal conversion have been observed. They were identified by comparing the observed energies with extrapolations of the Moseley relationship and assuming the identities, the agreement in energy was close. Estimates of relative intensity have been made on both the gamma and x radiation, and lead to the conclusion that the ratio of vacancies produced in the L shell by internal conversion is  $\text{L}_I:\text{L}_{II}:\text{L}_{III} = 6:5:2$ . A partial decay scheme is suggested and a number of the gamma-ray transitions are shown to be in good agreement with known spacings from alpha-particle complex structure.

414

Radiation Lab., Univ. of Calif.

**ISOMERIC STATES OF  $\text{Bi}^{210}$**  (abstract); by Harris B. Levy and I. Perlman. Oct. 19, 1951. 1p. (UCRL-1532)

The report is reproduced here in its entirety.

In 1950 Neumann, Howland, and Perlman (*Phys. Rev.* **77**, 720 (1950)) reported finding a possible isomer of RaE. Bismuth was irradiated at high neutron flux to produce  $\text{Bi}^{210}$ . After the RaE had decayed out, a residual long-lived alpha activity was found in the bismuth fraction. This alpha activity was assigned to  $\text{Bi}^{210}$  on the basis of experiments in which the  $\text{Tl}^{208}$  daughter was milked out. The alpha-particle energy was determined at that time to be  $5.03 \pm 0.05$  Mev, indicating that it was an excited state of RaE. Recently some of this bismuth fraction was electromagnetically separated, and the mass fractions 208, 209, and 210 were examined. The increase in the specific activity of the 210 mass fraction and the corresponding decrease in the specific activity of the 208 and 209 mass fractions confirmed the assignment of the alpha activity to  $\text{Bi}^{210}$ . The energy of the alpha particle was redetermined to be  $4.93 \pm 0.02$  Mev. The disintegration energy is therefore  $5.03 \pm 0.02$  Mev. Comparison with the latest calculated alpha disintegration energy of RaE, 5.06 Mev, leaves considerable doubt as to whether the long-lived alpha emitter or RaE is the ground state of  $\text{Bi}^{210}$ .

415

Radiation Lab., Univ. of Calif.

**COMPLEX ALPHA STRUCTURE OF THE HEAVY ELEMENTS** (abstract); by Frank Asaro, Fred L. Reynolds, and I. Perlman. Oct. 19, 1951. 1p. (UCRL-1533)

The report is reproduced here in its entirety.

A study of complex alpha-energy spectra was undertaken in the hope that a correlation with alpha systematics might promote a better understanding of nuclear states and their influence on the alpha-decay process. A 75-cm radius of curvature  $60^\circ$  symmetrical analyzer with photographic plate detection of alpha particles was used for the energy discrimination.

The complex alpha particle energy spectrum of  $\text{Cm}^{242}$  comprises two groups: one at  $6.110 \pm 0.003$  Mev,  $73 \pm 1\%$  abundant; and one group 45.9  $\pm 1.0$  kev lower in energy,  $27 \pm 1\%$  abundant. The complex alpha-particle energy spectrum of  $\text{Am}^{241}$  comprises six groups: 5.544 Mev,  $0.23 \pm 0.06\%$  abundant; 5.533 Mev,  $0.34 \pm 0.06\%$  abundant; 5.502 Mev,  $0.21 \pm 0.02\%$  abundant; 5.475 Mev,  $84.2\%$  abundant; 5.433 Mev,  $13.6 \pm 1.4\%$  abundant; 5.378 Mev,  $1.4 \pm 0.2\%$  abundant. The identification of the experimentally observed alpha groups with the alpha-emission spectra of the indicated nuclides is conclusively proved by the constancy of the respective energy differences and abundance ratios over wide ranges of sample activity prepared from different sources of material. In every case studied of even-even nuclei all groups lie very close to the alpha systematic half life vs. energy curves for even-even nuclides.

416

Radiation Lab., Univ. of Calif.

**ALPHA ACTIVITY IN  $\text{Bi}^{203}$  AS DETECTED WITH NUCLEAR EMULSIONS** (abstract); by Dean C. Dunlavey and Glenn T. Seaborg. Oct. 19, 1951. 1p. (UCRL-1534)

The report is reproduced here in its entirety.

Alpha emission of particle energy about 4.85 Mev has been observed in the bismuth fraction produced by the bombardment of lead with 60-Mev protons in the 184-in. cyclotron. The observed alpha decay has a half life approximating 12 hr. Correlation with the accompanying decay of the other radiation as measured with a Geiger counter (Neumann and Perlman, *Phys. Rev.* **78**, 191 (1950)) and with the alpha systematics indicates the emitting isotope to be  $\text{Bi}^{203}$  with a partial alpha half life of  $2 \times 10^4$  yr. Following chemical separation, the carrier-free bismuth was placed in a solution of pH about 4 and, for time intervals appropriately spaced following bombardment, impregnated into freshly eradicated Ilford C-2 nuclear emulsion plates. The associated gamma-conversion electron activity determined the maximum concentration of bismuth which could be tolerated by the emulsion without producing excessive fogging. Aliquots equal to those placed in the emulsion were counted in a windowless proportional counter to enable association of the alpha abundance found in the emulsion with the number of known over-all disintegrations. The alpha/K branching ratio was found effectively constant and reproducible at about  $10^{-7}$  over a series of experiments.

417

**DIRECTIONAL CORRELATION OF THE  $\gamma$ - $\gamma$  CASCADE OF  $\text{Cd}^{111}$** . H. Aeppli, H. Frauenfelder, and M. Walter. *Helv. Phys. Acta* **24**, No. 4, 335-42 (1951) Sept. 20. (In German)

The influence of the electron shell on the angular correlation of successive nuclear radiations is discussed. The anisotropy  $W(180^\circ)/W(90^\circ) - 1$  of the angular correlation of the  $\gamma$  rays depends in the case of  $\text{Cd}^{111}$  strongly on the nature of the source and varies between 0 and -0.20. The consequences of the measurements with sources of maximum anisotropy are the following: It is impossible to explain the observed angular correlation of  $\text{Cd}^{111}$  assuming only pure multipole transitions. The first  $\gamma$  ray has to be a mixture of electric quadrupole and magnetic dipole, the

intensity ratio being  $|\beta|^2 : |\alpha|^2 = 0.01 \pm 0.003$  and the relative nuclear phase  $\delta = 180^\circ$ . (auth)

418

INVESTIGATION OF THE  $\beta$  SPECTRUM OF RaD BY THE COINCIDENCE METHOD. Paul Falk-Vairant, Jean Teillac, and Charles Victor. *Compt. rend.* **233**, 1025-7(1951) Oct. 29. (In French)

Coincidence-counting experiments with Al and Au absorbers indicate that for every 100 disintegrations of RaD ( $\text{Pb}^{210}$ ) there are  $110 \pm 10$  electrons, consisting of 74 L and M + N + O conversion electrons (from the 47-keV  $\gamma$  of RaE ( $\text{Bi}^{210}$ )) and  $\sim 40$  Auger L electrons. The continuous  $\beta$  spectrum leading to the 47-keV excited state of RaE has an energy below 8 keV.

419

TERM DIAGRAMS OF SEVERAL NIOBIUM ISOTOPES. P. Preiswerk and P. Stähelin. *Helv. Phys. Acta* **24**, No. 4, 300-1(1951) Sept. 20. (In German)

A brief discussion of the decay of  $\text{Nb}^{98}$  is illustrated with a detailed energy-level diagram of  $\text{Mo}^{98}$ . An electron-capture process is reported for 10-day  $\text{Nb}^{92}$ ; 0.05% of all transformations are followed by a 930-keV  $\gamma$  of  $\text{Zr}^{92}$ . Transition energies for the 62-day  $\text{Nb}^{91m}$  and 80-hr  $\text{Nb}^{95m}$  have been measured as  $105.0 \pm 1.0$  and  $232 \pm 2$  keV, respectively, and ratios of K conversion to conversion in the other shells as  $2.1 \pm 0.1$  and  $3.5 \pm 0.9$ , respectively; magnetic  $2^4$ -pole radiation is indicated.

420

ON THE DISINTEGRATION OF  $8.0d$   $^{131}\text{I}$ . G. J. Nijgh, N. F. Verster, and R. H. Nussbaum, R. Van Lieshout, and C. J. Bakker. *Physica* **17**, 658-60(1951) July. (Letter to the editor)

Coincidence-absorption measurements of that part of the  $^{131}\text{I}$   $\beta$ -ray spectrum in coincidence with K-shell conversion electrons of the 80-keV transition are reported. The results are in agreement with the level scheme of Metzger and Deutsch (*Phys. Rev.* **74**, 1640(1948)) but not with those of Kern et al. (*Phys. Rev.* **76**, 94(1949)) or Cork et al. (*Phys. Rev.* **81**, 482(1951)).

421

$\gamma$  RADIATION OF  $\text{Ag}^{110}$ . B. S. Dzhelepov, N. N. Zhukovskii, and Yu. V. Khol'nov. *Doklady Akad. Nauk S.S.S.R.* **77**, No. 4, 597-8(1951) Apr. 1. (In Russian)

The  $\gamma$ -ray spectrum of  $\text{Ag}^{110}$  is shown. Four lines of  $652 \pm 7$  (1.00),  $886 \pm 9$  (1.03),  $1388$  (0.26), and  $1484$  (0.22) keV, where the figures in parentheses are relative intensities, were found. These are compared with the results of Siegbahn (*Phys. Rev.* **77**, 233(1950); NSA 4-1577); a line at 930 keV given by this author was not resolved in the present experiment.

422

MEASUREMENT OF THE RADIATIONS FROM  $^{131}\text{I}$  and  $^{131}\text{Xe}^*$  WITH A LENS TYPE BETA-RAY SPECTROMETER. N. F. Verster, G. J. Nijgh, R. Van Lieshout, and C. J. Bakker. *Physica* **17**, 637-57(1951) July.

A description is given of the construction of a lens-type spectrometer with an annular exit slit. A method for the adjustment of this slit is described. The instrument has a transmission of 1% and a line width of 2, 3, or 4% for sources of 3, 6, or 9 mm diam. The influence of radiator thickness on the shape of photoelectron lines has been studied.

The  $\beta$ - and  $\gamma$ -ray spectra of 8.0-day  $^{131}\text{I}$  have been investigated as well as the conversion spectrum of  $\text{Xe}^{131m}$ . Photoelectrons ejected from Pb and U by  $\gamma$  rays of 80, 284, 364, and 636.5 keV have been found. Internal-conversion electrons from all these  $\gamma$  rays are present. In sources which have aged for some days, conversion electrons from the 163-keV  $\gamma$  ray of 12-day  $\text{Xe}^{131m}$  appear. In the  $\beta$ -ray

spectrum of  $^{131}\text{I}$  two components of maximum energies 606 and 334 keV are easily found, both yielding straight Kurie plots. A very weak third component has been detected which is assumed to lead to the metastable Xe level. A very weak internal conversion line is found at 690 keV, corresponding to a hitherto unknown  $\gamma$  ray of 724 keV. A consistent spin and parity assignment to the levels is possible, the 606-keV  $\beta$  transition being allowed despite its high ft value of  $4.5 \times 10^6$ . (auth)

423

THE APPLICATION OF COLD WELDING TO SEALING SAMPLES FOR NEUTRON IRRADIATION IN A REACTOR. P. B. Aitken. *Rev. Sci. Instruments* **22**, 799-800(1951) Oct.

A capsule made of pure Al and sealed by cold welding, to contain material during neutron irradiation at high fluxes, is described. This capsule will stand an internal pressure of 500 psi.

424

USE OF THE SCINTILLATION SPECTROMETER IN THE INVESTIGATION OF NUCLEAR ENERGY LEVELS. Walter Steuber. Ph.D. thesis, University of Illinois, 1950.

The following information appears in *Microfilm Abstracts* **11**, No. 1, 152-3(1951).

The investigation demonstrated the usefulness of scintillation spectrometers for obtaining information on the decay schemes of  $\text{Ta}^{182}$  and  $\text{Ce}^{141}$ . The 525-keV  $\beta$  ray in  $\text{Ta}^{182}$  leads to  $\gamma$  rays of 74, 101, 1121, and 1189 keV but is not in coincidence with the last three. The  $\text{Ta}^{182}$  study did not lead to the proposal of a decay scheme since the problem is such that it will require the use of two very-high-resolution spectrographs operating in coincidence. The  $\text{Ce}^{141}$  decay scheme indicates a 420-keV  $\beta$  ray in coincidence with a 145-keV  $\gamma$ ; a 245-keV  $\beta$  ray in coincidence with a 315-keV  $\gamma$ ; and a 560-keV  $\beta$  ray not in coincidence with either  $\gamma$  radiation.

425

ON RADIOACTIVE DECAY AND THE RADIOACTIVE METHOD FOR DETERMINATION OF THE ABSOLUTE GEOLOGIC AGE OF ROCKS AND MINERALS.

N. S. Boganiuk. *Izvest. Akad. Nauk S.S.S.R. Ser. Geol.*, No. 4, 57-75(1951) July-Aug. (In Russian)

The assumption that radioactive decay in nature is independent of external circumstances is criticized as "idealistic." The author, who believes that pressure affects the decay rate, urges that the problem be approached from the point of view of Marxist-Stalinist dialectical materialism. Following the article are discussions of its content by A. P. Vinogradov, I. M. Frank, and I. E. Starik.

426

HALF-LIVES OF EXCITED STATES OF  $\text{Hg}^{199}$ ,  $\text{Xe}^{131}$ , and  $\text{Hg}^{180}$ . R. L. Graham and R. E. Bell. *Phys. Rev.* **84**, 380-1(1951) Oct. 15. (Letter to the editor)

The half life of the 158-keV excited state of  $\text{Hg}^{199}$  has been measured as  $2.35 \pm 0.20 \times 10^{-9}$  sec; that of the 80-keV excited state of  $\text{Xe}^{131}$  as  $4.8 \pm 2.0 \times 10^{-10}$  sec; and that of the 411-keV state of  $\text{Hg}^{180}$  as  $< 3 \times 10^{-11}$  sec. Delayed coincidence techniques previously described (*Phys. Rev.* **78**, 490(1950)) were used. Delayed resolution curves are shown, with prompt resolution curves included for comparison in the cases of  $\text{Hg}^{199}$  and  $\text{Xe}^{131}$ . The delayed resolution curve and its experimental inverse are compared for  $\text{Hg}^{198}$ .

427

DETERMINATION OF THE RELATIVE PROBABILITIES OF DISINTEGRATION BY K CAPTURE AND BY POSITRON EMISSION OF  $\text{Zn}^{65}$  IN THE WILSON CLOUD CHAMBER. John Keene Major. *Compt. rend.* **233**, 947-9(1951) Oct. 22. (In French)

The branching ratio  $P_K/P_{e^+}$  of  $\text{Zn}^{65}$  has been measured in a reduced-pressure Wilson cloud chamber by counting the tracks of K-capture photoelectrons and positrons. The resulting



value of  $25 \pm 10$  is in good agreement with Fermi's theory (Z. Physik 88, 161(1934)) but not with the modification of Konopinski and Uhlenbeck (Phys. Rev. 48, 7(1935)). Decision on the nature of the transition is not possible from this value.

428

STUDY OF THE  $\alpha$ -RAY SPECTRUM OF RADIUM. Geneviève Bastin-Scoffier. *Compt. rend.* 233, 945-7(1951) Oct. 22. (In French)

The existence of the third component  $\alpha_2$  at about 600 kev from the principal component  $\alpha_0$  of the Ra  $\alpha$  radiation has been confirmed by study of a strong source. Its intensity is about 3% of that of  $\alpha_1$ , which in turn is 7% of the intensity of  $\alpha_0$  (6.5% of the total intensity).

429

STUDIES ON THE RADIOACTIVITY OF THE ATMOSPHERE. Hubert Garrigue. *Compt. rend.* 233, 860-2(1951) Oct. 15. (In French)

The existence in the atmosphere of a radioactive substance, labeled "A," of several hours half life has been confirmed in flights at 3300 m and at a ground station at 1460 m. Concentrations of Rn, Tn, "A," and "A'" observed from Mar. 15 to Aug. 14, 1951, are tabulated. The concentration of substance "A," of 20- to 30-hr half life, is related to atomic explosions and precipitation.

430

THE CORRELATION IN THE DIRECTION AND THE POLARIZATION OF TWO SUCCESSIVE QUANTA. Arthur Hamilton Williams. Ph.D. thesis, University of Michigan, 1950.

The following information appears in *Microfilm Abstracts* 10, No. 4, 273-4(1950).

The correlation in the direction and the polarization during two successive transitions of  $\text{Rh}^{106}$ ,  $\text{Co}^{60}$ ,  $\text{Cs}^{134}$  were determined. In the case of  $\text{Rh}^{106}$ , verification was found with the experimental work done by Deutsch and Metzger. Both of the transitions in  $\text{Co}^{60}$  were found to be electric quadrupole, while in the case of  $\text{Cs}^{134}$  one of the transitions was electric quadrupole and the other was magnetic quadrupole.

431

NUCLEAR MATRIX ELEMENTS OF  $\beta$ -DECAY. Henry Brysk. *Phys. Rev.* 84, 362-3(1951) Oct. 15. (Letter to the editor)

The nuclear matrix elements have been evaluated (H. Brysk and E. Greuling, *Phys. Rev.* 83, 240(1951)) using a single-particle model, in the Dirac representation, for first-forbidden and l-forbidden ( $\Delta J = 1$ ,  $\Delta l = 2$ )  $\beta$  transitions in all forms of interaction. Values of  $\log(|M|^2 \text{ ft})$  have now been calculated, where  $|M|^2$  is the sum of the squares of the the matrix elements in a given interaction, each multiplied by its appropriate spectral correction factor. Some of the important results of the calculations are enumerated, and a complete listing of the matrix elements and values of  $\log(|M|^2 \text{ ft})$  will be published.

432

MEASUREMENT OF THE HALF LIFE OF A SHORT-LIVED ISOMERIC ACTIVITY PRODUCED IN LEAD BY FAST NEUTRONS. Jean Lascoux and Georges Vendryes. *Compt. rend.* 233, 858-60(1951) Oct. 15. (In French)

An isomeric activity of  $0.82 \pm 0.02$ -sec half life has been observed in Pb irradiated with neutrons from the  $\text{Be}^9(d,n)\text{B}^{10}$  reaction. The associated  $\gamma$  radiation agrees with the results of Campbell and Goodrich (*Phys. Rev.* 78, 640(1950)). The cross section of formation per atom of the natural Pb target was measured as  $1.5 \times 10^{-25} \text{ cm}^2$ , exact to a factor of 2.

433

TABLES OF DATA ON  $\beta$  DECAY. II. INFLUENCE OF COULOMB FIELD ON  $\beta$  SPECTRA. B. S. Dzhelepov and L. N. Zyryanova. *Zhur. Eksptl'. i Teoret. Fiz.* 21, No. 8, 923-41(1951) Aug. (In Russian)

The function  $F(E, Z)$  for the effect of the coulomb field on the shape of  $\beta$  spectra has been calculated for Z from 0 to 100 at intervals of five and for a single value of A for each Z for both electron and positron emission. The values are tabulated for energies from 1 kev to 10 Mev.

434

CONTINUOUS  $\gamma$ -SPECTRUM ACCOMPANYING ELECTRON CAPTURE. D. Maeder and P. Preiswerk. *Phys. Rev.* 84, 595-6(1951) Nov. 1. (Letter to the editor)

The shape of the low-energy  $\gamma$  spectrum accompanying the disintegration of  $\text{Fe}^{56}$  by K capture has been studied by means of NaI scintillating crystals. Good agreement between the experimental pulse distribution and the calculated one (Morrison and Schiff, *Phys. Rev.* 58, 24(1940)) is obtained for an upper limit of the  $\gamma$  spectrum at  $E_{\text{max}}(h\nu) = 0.205 \text{ Mev}$ . The upper limit corresponds to the case where the whole disintegration energy is taken away by the  $\gamma$  quantum, and from this upper limit the mass difference of the parent and daughter atoms  $\text{Fe}^{55}$  and  $\text{Mn}^{55}$  is calculated as  $0.212 \pm 0.010 \text{ Mev}$ .

435

$\text{Au}^{198}$  DECAY. A. R. Brosi, B. H. Ketelle, H. Zeldes, and E. Fairstein. *Phys. Rev.* 84, 586(1951) Nov. 1. (Letter to the editor)

Coincidence studies of the decay of  $\text{Au}^{198}$  have shown that the 680-kev  $\gamma$  is in coincidence with the 411-kev  $\gamma$  and also with the 290-kev  $\beta$ . The 290-kev  $\beta$  to the 1.09-kev level in  $\text{Hg}^{198}$  is followed by a 1.09-kev  $\gamma$  in  $\sim 1\%$  of the disintegrations and by a 680- and a 411-kev  $\gamma$  in  $\sim 0.2\%$ . The 970-kev  $\beta$  is also followed by a 411-kev  $\gamma$ .

436

GAMMA-COINCIDENT BETA-SPECTRA OF  $\text{I}^{131}$ . B. H. Ketelle, H. Zeldes, A. R. Brosi, and R. A. Dandl. *Phys. Rev.* 84, 585-6(1951) Nov. 1. (Letter to the editor)

In a study of  $\text{I}^{131}$  decay the  $\beta$ -energy distributions coincident with particular  $\gamma$  rays were measured. Pulses from the proportional-counter detector used with a magnetic-lens spectrometer were in coincidence with those from a scintillation spectrometer. With the aid of Kurie plots a decay scheme has been worked out consisting of the following: a 250-kev  $\beta$  followed by a 720-kev  $\gamma$  (2.3%), a 335-kev  $\beta$  followed by a 635-kev  $\gamma$  (7.7%), a 606-kev  $\beta$  followed by a 364-kev  $\gamma$  (80%) or by a 284- and an 80-kev  $\gamma$  (9.4%), and an 807-kev  $\beta$  followed by a 163-kev  $\gamma$  (0.6%).

437

A CARRIER-FREE SEPARATION OF UZ FROM UX.

F. Barendregt and S. J. Tom. *Physica* 17, 817-20(1951) Sept.

The Pa ( $\text{UX}_2 + \text{UZ}$ ) and Th ( $\text{UX}_1$ ) fractions of a carrier-free UX preparation in HCl were separated on an ion-exchange column eluted with 5% ammonium citrate solution. During the process the  $\text{UX}_2$  ( $\text{Pa}^{234\text{m}}$ ) decayed, so that carrier-free sources of 6.7-hr UZ ( $\text{Pa}^{234}$ ) were obtained, contaminated with only 0.8% of  $\text{UX}_1$  ( $\text{Th}^{234}$ ) radiations. The half life of  $\text{UX}_2$  was determined to be  $1.175 \pm 0.003 \text{ min}$ .

438

RECENT INVESTIGATIONS OF THE MAGNETIC  $\alpha$ -RAY SPECTRUM OF ThC AND THE LONG-RANGE PARTICLES OF ThC'. Albrecht Rytz. *Compt. rend.* 233, 790-2(1951) Oct. 8. (In French)

The following intensities in per cent have been measured for the  $\alpha$ -ray lines of ThC ( $\text{Bi}^{212}$ ):  $\alpha_0$ , 69.86 (2);  $\alpha_1$ , 27.16 (4);  $\alpha_2$ , 1.67 (3);  $\alpha_3$ , 1.08 (2 or 3);  $\alpha_4$ , 0.147 (4); and  $\alpha_5$ , 0.016 (4), where the figures in parentheses are j values. The existence of  $\alpha_5$  is thus confirmed. The long-range  $\alpha$  particles of ThC' ( $\text{Po}^{212}$ ) have been resolved as  $\alpha_1$ , 10.777;  $\alpha_{II}$ , 9.705; and  $\alpha_{III}$ , 10.655 Mev, of intensities 170, 35, and 20, respectively, with respect to  $\alpha_0$ , 8.974 Mev, intensity  $10^6$ . The  $\alpha_{III}$  line is reported for the first time.

439

THE BALANCE OF IONS IN THE ATMOSPHERE; THE PRODUCTION AND THE DISAPPEARANCE OF IONS.

J. Clay and H. Van Marle. *Physica* 17, 847-57(1951) Sept.

The sources of atmospheric ionization are cosmic radiation,  $\gamma$  radiation of the soil, a very small corpuscular radiation of the soil which does not noticeably influence results, and the ionization from the emanation in the atmosphere. It is argued that striking a balance of the ions in the atmosphere is not feasible by establishing the number of ions present and balancing it against the number of ions produced and disappeared, since the first-mentioned number depends entirely on a mobility limit in measurements. A useful method is to establish the number of ions produced above a certain mobility limit by measuring the conductivity in the aspirator and recombination vessel. As conductivity changes with duration of measurement, a better way is to measure the total number of fast newly produced ions in the free atmosphere in a double cage of wire netting and to measure separately the fast ions produced by every known agent. The situation is simplest above the ocean, where cosmic radiation is the only agent.

440

GAMMA-RAYS FROM THE DEUTERON BOMBARDMENT OF BORON AND THE PROTON BOMBARDMENT OF ALUMINIUM. J. G. Rutherglen, E. R. Rae, and R. D. Smith. *Proc. Phys. Soc. (London)* 64A, 906-14(1951) Oct.

The  $\gamma$ -ray spectra from the nuclear reactions  $B^{10} + d$ ,  $B^{11} + d$ , and  $Al^{27} + p$  have been measured with a pair spectrometer. Lines are found from  $B^{10} + d$  at  $8.88 \pm 0.06$  Mev,  $6.7 \pm 0.15$  Mev,  $6.4 \pm 0.15$  Mev, and  $4.38 \pm 0.05$  Mev; from  $B^{11} + d$  at  $4.44 \pm 0.05$  Mev; and from  $Al^{27} + p$  at  $12.12 \pm 0.1$  Mev,  $10.46 \pm 0.07$  Mev, and  $7.62 \pm 0.1$  Mev. The correlation of these  $\gamma$ -rays with the energy levels of the nuclei involved is discussed. (auth)

SHIELDING

441

Oak Ridge National Lab.

NEUTRON SHIELDING; by Richard Stephenson. [nd] Dec. 1. July 16, 1951. 6p. (AEC-3272; CF-51-6-93)

Shielding against neutrons is a complex problem because of the different forms of the scattering functions and the different variations of the cross sections with energy. The basic principles are briefly discussed and compared with those of gamma shielding. Examples are given of calculations of thickness of water and of paraffin which will produce a given reduction of neutron intensity.

442

B. F. Goodrich Co.

ELASTOMERIC MATERIALS AS SHIELDING COMPOUNDS FOR NUCLEAR REACTORS; by W. L. Davidson. Oct. 1, 1951. 7p. Bound with: ELASTOMERIC MATERIALS AS SHIELDING COMPOUNDS FOR NUCLEAR REACTORS; by W. L. Davidson. July 1, 1951. 4p. (ORO-53)

The possibility of developing elastomeric compounds for use as shielding components in reactors is surveyed. A compilation of data is given on the pertinent physical properties of commercial elastomers.

SPECTROSCOPY

443

Brookhaven National Lab.

SPECTROSCOPY OF RADIOACTIVE MOLECULES (abstract); by V. W. Cohen. Oct. 19, 1951. 1p. (BNL-1014)

The report comprises an abstract of a paper for the meeting of the New York Academy of Sciences, Nov. 9 and 10, 1951, and is reproduced here in its entirety.

The interest in the spectroscopy of radioactive molecules is primarily for the purpose of determining the properties of the radioactive nucleus. A discussion is given on the principal problems arising in this field. They are (1) to prepare the nucleus by suitable irradiation, either with pile neutrons or deuterons in a cyclotron or by extraction of fission products, (2) high-efficiency chemical conversion of the product nucleus without carrier material into a compound suitable for spectroscopic analysis, (3) spectroscopic analysis with minute amounts of material. Results to date have been obtained on the following isotopes:  $H^3$ ,  $C^{14}$ ,  $Na^{22}$ ,  $Na^{24}$ ,  $S^{35}$ ,  $Cl^{36}$ ,  $Rb^{86}$ ,  $I^{129}$ ,  $Cs^{134}$ . Based upon elements that have been studied in the stable form, a list is given of those artificially radioactive nuclei which appear as promising subjects for microwave spectroscopy.

444

Norman Bridge Lab. of Physics, Calif. Inst. of Tech. FUNDAMENTAL RESEARCH IN SPECTROSCOPY OF SHORT WAVE-LENGTH X-RAYS AND GAMMA-RAYS; SIXTEENTH QUARTERLY REPORT; PERIOD JANUARY 1st TO MARCH 31, 1951; by Jesse W. M. DuMond. 14p. [nd] (NP-3142)

Extensive precision wavelength and quantum-energy measurements of  $\gamma$ -ray and x-ray lines accompanying the decay of the neutron-activated radioisotopes  $Ir^{192}$  and  $W^{187}$  with the 2-meter curved-crystal  $\gamma$ -ray spectrometer are described. Reflections of  $\gamma$ -rays from the (310) planes of quartz have been observed up to and including the third order by means of the new NaI scintillation-crystal detector. Conclusions are drawn concerning the decay schemes of  $Ir^{192}$  and  $W^{187}$ . The  $\gamma$ -ray spectrum accompanying decay of  $Ta^{182}$  is described; many new lines were observed. Results of precision measurements of  $\gamma$ - and x-ray lines accompanying the decay of Ra and Th are tabulated. A new recalibration of the screw conversion factor of the 2-m instrument is described. The first successful operation of the point-focusing x-ray monochromator for low-angle x-ray diffraction is discussed. The progress of the axial-focusing magnetic  $\beta$ -ray spectrometer is outlined.

445

Southern California Univ.

ISOTOPE SHIFT IN THE ATOMIC SPECTRUM OF CARBON AND NITROGEN (Technical Report No. 1); by John R. Holmes. Feb. 1, 1950. 24p. (NP-3189)

The spectrum of a small sample of carbon enriched in  $C^{13}$  has been excited in an electrodeless discharge. The only line which appears with appreciable intensity is at  $2478 \text{ \AA}$  ( $2s^2S_0 - 3s^2P_1$ ). The isotope shift in this line was measured with a Fabry-Perot interferometer and was minus  $0.156 \pm 0.002 \text{ cm}^{-1}$ . The normal mass effect produced by the change in the Rydberg constant is plus  $0.142 \text{ cm}^{-1}$ . Some of the infrared lines of nitrogen were excited in a mixture of helium and an enriched sample of  $N^{15}$  in an electrodeless discharge. The isotope shifts in these lines were measured by comparison with some adjacent nitrogen lines which had been previously measured. The results are tabulated. (auth)

446

Norman Bridge Lab. of Physics, Calif. Inst. of Tech. FUNDAMENTAL RESEARCH IN SPECTROSCOPY OF SHORT WAVE-LENGTH X-RAYS AND GAMMA RAYS; FIFTEENTH QUARTERLY REPORT; OCTOBER 1-DECEMBER 31, 1950; by Jesse W. M. DuMond. [nd] 14p. (NP-3262)

The operation of a scintillation counter detecting system for a 2-meter crystal spectrometer is discussed. Work on four new  $\gamma$ -ray sources ( $Rn$ ,  $W^{187}$ ,  $Th$ , and  $In^{192}$ ) are described.



The precision measurements of the  $\gamma$ -ray spectrum of Rn showed lines with approximate quantum energies of 52.8, 241, 294, 350, 608, and 766 kev. Measurements of  $W^{187}$  showed lines with approximate quantum energies of 72, 134, 480, 617, and 686 kev. With the high precision obtained it could be shown that the 4th of these W lines is different from the sum of the 2nd and 3rd. Wavelength measurement of radiothorium  $\gamma$  rays shows a line at 238 kev and a weak line at slightly lower energy. This is the first time these two lines have been resolved. Wavelength measurements on  $Ir^{192}$  showed 27  $\gamma$ -ray lines, 8 x-ray lines, and 5 2nd-order lines.

447

Princeton Univ.

THE POSITRONIUM FINE STRUCTURE; by Richard A. Ferrell. Sept. 26, 1951. 5p. (NYO-3000)

The fine structure of the positronium energy levels was worked out by Pirene (Arch. sci. phys. et nat. 29, 265 (1947)) and by Berestetski (J. Exptl. Theoret. Phys. U.S.S.R. 19, 1130(1949)) apparently independently. The calculations have been redone and the errors found in each paper corrected. An energy-level diagram of the intrinsic positronium fine structure is given. The Lamb shift in positronium was found to be about one-half the corresponding shift in H and it did not have any effect on the fine structure.

448

Office of Naval Research, London

MOLECULAR SPECTROSCOPY CONFERENCE IN BASEL; June 28 - 30, 1951; by George J. Szasz. July 20, 1951. 17p. (ONRL-62-51)

449

Carbide and Carbon Chemicals Co., Y-12

X-RAY SPECTRA OF POLONIUM; by Frances L. Sachs. Nov. 26, 1951. 6p. (Y-B4-49)

This bibliography contains ten references to published papers on the K, L, and M series of the x-ray spectra of polonium. Abstracts of the papers are included.

450

TWO-DIRECTIONAL FOCUSING OF CHARGED PARTICLES WITH A SECTOR-SHAPED, UNIFORM MAGNETIC FIELD. William G. Cross. Rev. Sci. Instruments 22, 717-22(1951) Oct.

For a sector-shaped, uniform magnetic field with source and detector outside the field, the nonuniform fringing fields can be employed to give simultaneous focusing of charged particles in two perpendicular directions. Equations for determining the position of the doubly-focused image are developed and graphs are given for some representative arrangements. This double focusing can be combined with the methods recently developed for second-order focusing, to increase further the useful solid angle of a uniform-field mass or momentum analyzer. Fringing-field focusing can also be used in concentrating to a point a parallel beam of finite cross section. (auth)

451

RADIATIVE CORRECTIONS TO THE HYPERFINE STRUCTURE AND THE FINE STRUCTURE CONSTANT. Norman M. Kroll and Franklin Pollock. Phys. Rev. 84, 594-5(1951) Nov. 1. (Letter to the editor)

A calculation is made of the second-order radiative corrections to the hyperfine structure and the fine-structure constant  $\alpha$ . The evaluation is confined to that part of the energy which is of order  $\alpha^2 z$  relative to the Fermi formula. The total correction is  $\sim -1.81 \alpha^2 z$ , which reduces the value of  $\alpha^{-1}$  obtained from the hyperfine structure from 137.043 to 137.036.

## THEORETICAL PHYSICS

452

ON A CLASSICAL MODEL OF THE ELEMENTARY PARTICLE. Antoine Visconti. Compt. rend. 233, 852-4 (1951) Oct. 15. (In French)

The ensemble of mesonic masses associated with a particle is treated, in the framework of the subtractive field theory, as a compressible fluid in which a deformation, caused by a proper oscillation of the particle, is propagated with the velocity  $c$ .

453

ON QUANTUM ELECTRODYNAMICS. J. G. Valatin. Kgl. Danske Videnskab. Selskab, Mat. fys. Medd. 26, No. 13, 1-32(1951).

A formulation of quantum electrodynamics, without a supplementary condition, is given. Starting from the interaction representation, light waves are characterized by the 6-vector field satisfying the homogeneous Maxwell equations. In order to describe longitudinal interactions, an additional scalar field is introduced. Interactions with the electrons are defined by means of potentials given by these fields and related to a special time-like vector  $n_\mu$  (or to a corresponding space-like surface). The scalar field variables can be eliminated by means of a canonical transformation which leads to a wave equation containing the transverse interaction energy and the Coulomb energy. In the Heisenberg representation, the potentials whose gauge is related to the special time-like vector  $n_\mu$  do not satisfy the Lorentz condition. The field strength operators obey, however, the Maxwell equations. In calculating the S-matrix, the commutation rules of the potentials which depend on  $n_\mu$  can be replaced by the simpler rules of the Fermi electrodynamics. (auth)

454

A NEW MATHEMATICAL MODEL OF THE ELECTRON LENS. Pierre Grivet. Compt. rend. 233, 921-3(1951) Oct. 22. (In French)

A function is derived which describes with precision the axial field of numerous electron lenses in which the decrease of field strength with distance is due to shielding. The function provides a practical expression of the optical characteristics.

455

RADIATION CORRECTIONS IN QUANTUM ELECTRODYNAMICS. A. D. Galanin. Doklady Akad. Nauk S.S.S.R. 79, No. 2, 229-32(1951) July 11. (In Russian)

456

A PERTURBATION TREATMENT OF CLOSED STATES IN QUANTIZED FIELD THEORIES. B. Touschek. Phil. Mag. (7) 42, 1178-84(1951) Oct.

An iteration method is discussed for obtaining approximate solutions for field theoretical problems involving bound states. The method consists in adding a suitable operator representing an interaction energy to the hamiltonian of the free particles (nucleons and mesons) and subtracting it from the customary interaction energy, which represents the possibility of creating or annihilating Bose particles by a corresponding transition of the Fermi field. The interaction operator thus introduced is subject to the additional requirement that it should leave the number of Bose particles unaltered. It may be such that bound states occur between nucleons or mesons, or even between nucleons and mesons. Orthodox perturbation theory is then applied to the new perturbation energy, i.e., to the creation-annihilation term minus the supplementary interaction term. The point of the method is that wave functions of the right asymptotic behavior—i.e., that of bound states—are forced on the formalism before the perturbation treatment begins.

457

RELATIVISTIC THEORY OF SPIN. Yu. M. Shirokov. *Zhur. Eksptl'. i Teoret. Fiz.* **21**, No. 6, 748-60(1951) June. (In Russian)

Certain relativistic invariant calculations of spin and center of inertia of point particles are discussed. A covariant separation of spin moment from orbital moments is derived, and evidence is presented for the possibility of a relativistic classification of states of an arbitrary particle. A relativistic theory of the mass center is applied to the oscillation of the Dirac electron. It appears possible to obtain the increase (with increase of spin) of the mass spectrum of particles with continuous internal degrees of freedom.

458

THE NORMALIZATION GROUP IN QUANTUM THEORY. E. C. G. Stueckelberg and A. Petermann. *Helv. Phys. Acta* **24**, No. 4, 317-19(1951) Sept. 20.

Dyson's method (*Phys. Rev.* **78**, 1736(1949)) is generalized in order to discuss complex interactions. A chosen set of local interactions  $\sigma_e$  cannot be introduced without in general adding interactions up to an infinite order in the derivatives of  $\delta(x)$  and involving actions between any number of quanta. The only exceptions are actions of zero order involving three and four scalar fields, and actions of zero or first order between a vector field and two spinor or two scalar fields, if the corresponding charge satisfies continuity. Nonlocal interactions of the type  $\sigma(xx')$  between the charge and vector field are possible without contradicting macroscopic causality, if the Fourier representation  $\sigma(p^2)$  has only complex singularities. If this finite extension is developed in terms of  $p^2$  all multipole actions are found. This theory should be considered as a phenomenological approach to a true description of spin-1 particles, in which they appear as bound states of an even number of elementary particles of spin  $\frac{1}{2}$ .

## PATENTS

### CHEMISTRY

459

HIGH-PRESSURE POLYMERIZATION OF PERHALOOLEFINS. W. T. Miller (to U. S. Atomic Energy Commission). U. S. Patent 2,567,956, Sept. 18, 1951.

This patent pertains to a method of producing commercially satisfactory solid polymers from halogenated compounds of carbon and fluorine or carbon, fluorine, and chlorine containing 2 to 4 carbon atoms. Polymerization is accomplished in the presence of a small amount of a chemical promoter such as benzoyl peroxide at a temperature in the range of from room temperature to 70°C and under a pressure of from 10,000 to 20,000 kg/cm<sup>2</sup>.

460

PROCESS OF PRODUCING URANIUM HEXACHLORIDE. F. A. Jenkins (to U. S. Atomic Energy Commission). U. S. Patent 2,572,156, Oct. 23, 1951.

This patent describes a process for producing uranium hexachloride. Uranium pentachloride is heated to a temperature in the range of 80 to 180°C and under a pressure of about 10<sup>-3</sup> mm Hg or less, whereupon uranium hexachloride sublimes and is separately condensed.

461

MANUFACTURE OF POROUS ARTICLES FROM TRIFLUOROCHLOROETHYLENE POLYMER. M. A. Coler (to U. S. Atomic Energy Commission). Patent 2,573,639, Oct. 30, 1951.

This patent discloses a method of preparing a porous article of trifluorochloroethylene polymer. The finely divided powder of the polymer is cold-molded at a pressure greater than 500 psi and after removal from the mold is sintered at an elevated temperature not in excess of 250°C.

462

GAS ANALYZER. A. O. C. Nier (to U. S. Atomic Energy Commission). U. S. Patent 2,573,649, Oct. 30, 1951.

This patent describes a gas analyzer for continuously determining the composition of a binary gaseous mixture having a condensable component which has a high degree of relative accuracy under changing conditions of flow and composition.

463

MANUFACTURE OF URANIUM TETRACHLORIDE. M. D. Kamen (to U. S. Atomic Energy Commission). U. S. Patent 2,574,268, Nov. 6, 1951.

This patent relates to a process for producing uranium tetrachloride. An oxide of uranium is reacted with trichloro-

roacetyl chloride within a temperature range of 135 to 225°C and at substantially atmospheric pressure.

464

PROCESS FOR THE PREPARATION OF FLUOROCARBONS. G. H. Cady (to U. S. Atomic Energy Commission). U. S. Patent 2,574,619, Nov. 11, 1951.

This patent covers a method of producing saturated fluorocarbons. Hydrocarbon in vapor phase and fluorine gas each diluted with an inert constituent such as nitrogen are introduced separately into a reaction chamber where the mixture comes in contact with a heat-conductive metal base having thereon an adherent layer of a metal fluoride such as silver, cobalt, manganese, or cerium at a temperature of 100 to 400°C. Subsequently the fluorocarbon is separated from the resultant product.

465

ALKYL ETHER OF CHLOROFLUOROHEPTENE. E. T. Mc-Bee and W. S. Barnhart (to U. S. Atomic Energy Commission). U. S. Patent 2,574,649, Nov. 13, 1951.

This patent describes a method for the production of novel ethers of halogenated heptenes containing at least 8 fluorine atoms in the heptene radical. These alkyl ethers are prepared by reacting a metal alcoholate with a highly fluorinated product of halogenated heptene.

466

METHODS AND APPARATUS FOR PURIFYING AND PACKAGING URANIUM HEXACHLORIDE. C. H. Prescott, Jr. (to U. S. Atomic Energy Commission). Patent 2,574,842, Nov. 13, 1951.

This patent pertains to a method for preparing and packaging uranium hexachloride comprising heating uranium pentachloride at a temperature below about 250°C and condensing the uranium hexachloride sublimate in a separate zone, subsequently transferring the solid sublimate to another container and hermetically sealing it, all the while maintaining the system under a vacuum.

467

THE PREPARATION OF HEAVY METAL BOROHYDRIDES. H. R. Hoekstra and J. J. Katz (to U. S. Atomic Energy Commission). Patent 2,575,760, Nov. 20, 1951.

This patent covers borohydrides of zirconium or hafnium of certain specified melting and boiling points and methods of preparation. These borohydrides may be prepared by the reaction between an alkali-metal double fluoride of zircon-



nium or hafnium with a borohydride such as aluminum borohydride in an inert atmosphere.

468

**METHOD FOR SEPARATION OF AMERICIUM FROM SOLUTIONS CONTAINING THE SAME.** L. B. Werner (to U. S. Atomic Energy Commission). U. S. Patent 2,577,097, Dec. 4, 1951.

This patent pertains to a method for the separation of americium from a solution containing the same and certain other trivalent elements. The separation may be accomplished by using a hypochlorite to oxidize the americium to the pentavalent state in a strong carbonate solution, thereby obtaining an insoluble americium composition which may be removed from the solution.

469

**METHOD FOR REMOVAL OF RADIOACTIVE CONTAMINANTS.** J. DeMont (to U. S. Atomic Energy Commission). U. S. Patent 2,577,514, Dec. 4, 1951.

This patent describes a method for removing radioactive contamination from the surface of an object, comprising treating the contaminated surface with a solution of sodium silicate, followed by a wash with a strong mineral acid, and removing the resulting decomposition products and therewith a portion of the radioactive contaminants.

470

**VACUUM SEAL FOR FLUORINE GENERATION SYSTEM.** D. O. Hubbard (to U. S. Atomic Energy Commission). U. S. Patent 2,579,234, Dec. 18, 1951.

This patent describes a hydraulic inert liquid for an electrolytic gas-generating system in conjunction with an associated reservoir of inert gas so that a pressure-liquid-level balance is maintained in the cell under normal operating conditions, while providing for the introduction of the inert gas to break the partial vacuum created by too rapid a withdrawal of the electrolytic gas or similar malfunctioning operation.

#### MINERALOGY, METALLURGY, AND CERAMICS

471

**URANIUM-COBALT ALLOYS.** A. H. Daane and W. K. Noyce (to U. S. Atomic Energy Commission). U. S. Patent 2,574,626, Nov. 13, 1951.

This patent covers a new uranium-cobalt alloy having a composition corresponding to the formula  $UCo_2$ .

472

**URANIUM-COBALT ALLOYS.** A. H. Daane and W. K. Noyce (to U. S. Atomic Energy Commission). Patent 2,574,627, Nov. 13, 1951.

This patent covers a new uranium-cobalt intermetallic compound, corresponding to the formula  $U_6Co$ , which has a density of about 17.7 g/cm<sup>3</sup>.

#### PHYSICS

473

**MASS SPECTROGRAPH.** A. J. Dempster (to U. S. Atomic Energy Commission). U. S. Patent 2,572,600, Oct. 23, 1951.

This patent covers an improved mass spectrograph in which correction for the divergence or convergence of the associated ion beam is obtained by providing adjustable magnetic-lens equipment to afford a variable angle of incidence at the entrant boundary of the homogeneous magnetic field.

474

**METHOD AND APPARATUS FOR MEASURING STRONG ALPHA EMITTERS.** E. G. Segrè (to U. S. Atomic Energy Commission). U. S. Patent 2,573,069, Oct. 30, 1951.

This patent describes an apparatus and method for the determination of the strength of a strong alpha emitter. The apparatus is so arranged that the alpha particles impinge upon a material which emits neutrons as a result of such bombard-

ment. The neutrons so obtained in turn impinge upon a monitoring material and cause radioactivity in such monitoring material. By determining the amount of radioactivity in the last-named material under standardized conditions, one obtains the relative strength of the alpha emitter.

475

**RADIATION DETECTION AND MEASURING APPARATUS AND METHODS.** D. W. Engelkemeir and N. Sugarman (to U. S. Atomic Energy Commission). U. S. Patent 2,574,632, Nov. 13, 1951.

This patent pertains to an improved apparatus and method for the detection and comparative measurement of positive and negative beta-particle radiation useful in determining the relative amounts of the different radiations emitted from a single sample of material. The sample of radioactive material is held in proximity to a strong unidirectional magnetic field in such a manner that the beta particles emitted will be directed transversely to the field. By means of removable shields and suitable detecting apparatus the relative intensity of the positive and negative beta-particle radiation is determined.

476

**APPARATUS FOR FOCUSING HIGH-ENERGY PARTICLES.** W. K. H. Panofsky and W. R. Baker (to U. S. Atomic Energy Commission). U. S. Patent 2,574,655, Nov. 13, 1951.

This patent covers a magnetic arc lens suited to disposition in the path of and parallel to a beam of high-energy particles. By employment of suitable equipment and proper pulsing, an arc is established between the electrodes disposed in the path of the beam, which arrangement develops a magnetic field having a focusing action on the particles comprising the beam.

477

**MATERIALS AND METHODS FOR RADIOGRAPHY.** W. H. Zinn (to U. S. Atomic Energy Commission). U. S. Patent 2,574,681, Nov. 13, 1951.

This patent describes a method for radiographing objects consisting in placing the object to be radiographed between a cadmium element and a gamma-radiation-sensitive film at a substantial distance from the cadmium element, and exposing the cadmium element to a collimated beam of slow-neutron radiation, said film being placed out of the path of the neutron beam.

478

**TIMING APPARATUS.** W. M. Powell and A. W. Hughes (to U. S. Atomic Energy Commission). U. S. Patent 2,574,841, Nov. 13, 1951.

This patent covers a new and improved fast timing means suitable for controlling the final stages of cloud-chamber operations in conjunction with a particle accelerator. The mechanical driving structure affords intermittent rotation of a timer shaft having a plurality of adjustable switch elements. Moving parts are designed to have relatively small inertia.

479

**COUNTER CHRONOGRAPHS.** W. A. Higinbotham and B. D. McDaniel (to U. S. Atomic Energy Commission). U. S. Patent 2,575,759, Nov. 20, 1951.

This patent describes a simply constructed precise electronic chronograph for measuring time intervals of the order of hundreds of microseconds. The control means are quick acting and automatically reset the system for successive timing operations.

480

**DEVICES FOR GENERATING NEUTRONS.** A. O. Hanson (to U. S. Atomic Energy Commission). Patent 2,576,600, Nov. 27, 1951.

This patent describes a neutron-generating device which will operate at a uniform output level. The generator em-

plays a high-energy-particle beam which impinges upon a target of a nuclear disintegrable material, said target being rotatable and so arranged that only a part of the target area is normally subjected to the particle beam at any one time.

481

**METHODS OF ACCELERATING IONS.** E. E. Hays (to U. S. Atomic Energy Commission). Patent 2,567,601, Nov. 27, 1951.

This patent describes a method of operating an ion source so as to produce a large number of ion pulses, accelerate the ion to uniform momenta, produce a large number of ions which travel in a uniform direction from the source, and cause ions of different weights to describe the same path through a magnetostatic field.

482

**MONITORS FOR FISSION GASES.** R. Livingston and H. A. Levy (to U. S. Atomic Energy Commission). U. S. Patent 2,576,616, Nov. 27, 1951.

This patent covers an apparatus useful in monitoring a gaseous medium for the presence of radioactive gases of short half life. The gas stream to be monitored is caused to pass through an electrostatic precipitation chamber in such a manner that the solid decay products are deposited on a wire disposed substantially along the axis of the chamber, the wire being arranged so as to be movable along the axis and removable through an opening in the chamber and examined externally of the chamber for the presence of radioactivity.

483

**PULSE SHAPING CIRCUITS.** L. F. Wouters (to U. S. Atomic Energy Commission). U. S. Patent 2,576,661, Nov. 27, 1951.

This patent describes a pulse-shaping circuit which is particularly useful in connection with a photomultiplier-tube circuit employed in scintillation counting. In this circuit, positive feedback is utilized to discharge interelectrode and distributed capacitance, and a square pulse is formed in response to a sharply rising pulse having a trailing decay time.

484

**PRESSURE MEASURING DEVICE.** W. A. Arnold (to U. S. Atomic Energy Commission). U. S. Patent 2,577,066, Dec. 4, 1951.

This patent describes an oscillation-type pressure gage which is reliable and accurate up to a pressure value of the order of  $20\mu$ . The improved characteristics of this gage are obtained by employing an annular anode and an annular cathode, annularly spaced from one another, so that an electric-discharge region of accurate cross section is defined by the intervening annular space between the electrodes.

485

**ELECTRIC POSITIONING PROPORTIONAL FLOATING CONTROL.** T. A. Abbott and J. B. McMahon (to U. S. Atomic Energy Commission). U. S. Patent 2,577,696, Dec. 4, 1951.

This patent describes an improved electrical system for use with a proportional position controller. The system employs essentially two Wheatstone-bridge networks having a common impedance branch, arranged so that opposite arms are variable differentially in accordance with changes in the controlled variable.

486

**PULSE TRANSFORMER.** Q. A. Kerns and W. R. Baker (to U. S. Atomic Energy Commission). U. S. Patent 2,577,707, Dec. 4, 1951.

This patent pertains to an improved compact pulse transformer having low leakage inductance and a large voltage

rating, capable of operating upon voltage pulses of very short rise time and duration and very rapid repetition rate.

487

**ELECTROMAGNETICALLY OPERATED COUNTER.** H. D. Goldberg and M. I. Goldberg (to U. S. Atomic Energy Commission). U. S. Patent 2,579,231, Dec. 18, 1951.

This patent describes a simple and reliable electromagnetically operated counter, having very little moment of inertia and low friction loss, and so constructed that an electrical impulse produces unidirectional, stepwise rotation of a counting shaft.

488

**RECTIFIER SYSTEM.** Q. A. Kerns (to U. S. Atomic Energy Commission). U. S. Patent 2,579,235, Dec. 18, 1951.

This patent describes an improved polyphase low-voltage high-current rectifier system which is easily controlled and regulated by a negative feedback connection. In the system, two polyphase transformers are interconnected so that the current flow in the secondary windings of one transformer is electronically controlled to determine the output of the second transformer.



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# NUMERICAL INDEX OF REPORTS

Numerical Index of Official Atomic Energy Reports with Indications of Their Availability

This list in the individual issues of Volume 6 supplements the Numerical Index of Reports with Indications of Their Availability which appears in NSA, Volume 5, No. 24. As reports are in manuscript form when abstracted for NSA, there may be some delay before the reports will be available at the Depository Libraries. The notation NSA in the Availability column indicates the appearance of a report in its entirety in NSA.

Abbreviations used below are:

NSA - NUCLEAR SCIENCE ABSTRACTS  
ADD - ABSTRACTS OF DECLASSIFIED DOCUMENTS  
the predecessor of NSA  
NNES - National Nuclear Energy Series, published by  
the McGraw-Hill Book Company

AECD - To declassified reports released by the Atomic  
Energy Commission after February 29, 1948  
(appeared in April 15, Nuclear Science Ab-  
stracts)

AECU - To unclassified reports originating within the  
Atomic Energy Project. (Subsequent to AECU-  
871, this code is applied only to reports carry-  
ing no other recognized code designation.)

Code designations are assigned as follows:

MDDC - To declassified reports released by the Man-  
hattan Engineer District and by the Atomic  
Energy Commission before March 1, 1948

Other code designations below are assigned to unclassified  
reports by the originating installations

Report	Abstract	Availability	Report	Abstract	Availability
AECD-2877	NSA 4-5405	J. Am. Chem. Soc. 73, 5436-8(1951)	CUD-52	NSA 5-6804	Rev. Sci. Instruments 21, 978-85(1950)
3067	5-2900	Record Chem. Progress 12, 117-25(1951)	LA-1224	5-3922	J. Am. Chem. Soc. 73, 5307-08(1951)
3155	5-4125	J. Am. Chem. Soc. 73, 5215-17(1951)	NP-3392	5-6724	Trans. Am. Soc. Mech. Engrs. 73, 609-20 (1951)
3228	5-6872	\$0.20			
AECU-1206	5-3373	J. Am. Chem. Soc. 73, 5213-15(1951)	3474	5-6215	J. Metals (N. Y.) 3, 643-52(1951)
1289	5-3634	J. Am. Chem. Soc. 73, 4853-5(1951)	NYO-661	5-4697	J. Am. Chem. Soc. 73, 5218-19(1951)
1324	5-4273	Phys. Rev. 82, 827-31(1951)	735	5-4701	J. Am. Chem. Soc. 73, 5223-4(1951)
1340	5-4113	J. Am. Chem. Soc. 73, 5179-81(1951)	ORNL-840	5-2113	J. Am. Chem. Soc. 73, 5091-3(1951)
1401	5-5159	J. Am. Chem. Soc. 73, 5391-2(1951)	ORNL-841	5-963	J. Am. Chem. Soc. 73, 5091-3(1951)
1405	6-5259	Rev. Sci. Instruments 22, 753-7(1951)	893	5-2534	Rev. Sci. Instruments 22, 761-5(1951)
1431	5-4902	Phys. Rev. 83, 166(1951)	905	5-3192	Nucleonics 9, No. 3, 40-3, 94(1951)
1458	5-5044	J. Immunol. 67, 207-12(1951)	ORO-33	5-5364	\$0.30
1473	5-5226	J. Eng. Education 42, 93-6(1951)	TID-3013	5-6678	0.10
1499	5-4590	Phys. Rev. 84, 484-6(1951)	UCLA-139	5-5320	Nucleonics 9, No. 3, 72-5(1951)
1523	5-5019	J. Clin. Invest. 30, 1238-42(1951) Nov.	UCRL-1357	5-5380	Phys. Rev. 84, 463-5(1951)
1538	5-5021	J. Clin. Invest. 30, 1228-37(1951)	1418	5-5129	J. Chem. Phys. 19, 1426(1951)
1561	5-5353	Phys. Rev. 84, 401-8(1951)	1419	5-5130	J. Chem. Phys. 19, 1426-7(1951)
1643	5-6902	Phys. Rev. 84, 382-3(1951)	1420	5-5131	J. Chem. Phys. 19, 1427(1951)
1648	5-6874	Phys. Rev. 84, 589(1951)	1421	5-5132	J. Chem. Phys. 19, 1427(1951)
1649	5-6901	Phys. Rev. 84, 588-9(1951)	1422	5-5123	J. Chem. Phys. 19, 1428(1951)
1650	5-6558	J. Philadelphia Gen. Hosp. 2, 136-41(1951)	UR-172	5-4365	J. Biol. Chem. 193, 237-41(1951)
1659	5-6852	Phys. Rev. 84, 168(1951)	WASH-28	5-3444	Phys. Rev. 82, 885-92(1951)
1709	5-4893	Phys. Rev. 82, 927-31(1951)			





# NEW NUCLEAR DATA

Summary of New Nuclear Data on Half Lives, Radiations, Relative Isotopic Abundances, Nuclear Moments, Neutron Cross Sections, Reaction Energies, and Masses

Prepared by National Bureau of Standards Nuclear Data Group with the Assistance of Readers

National Bureau of Standards Group: K. Way, G. H. Fuller, M. Wood, K. Thew, and A. Jurgens

Readers: G. Friedlander and G. Scharff-Goldhaber, Brookhaven National Laboratory; P. Axel and R. B. Duffield, University of Illinois; J. R. Stehn, Knolls Atomic Power Laboratory; J. S. Smart, Naval Ordnance Laboratory; L. Slack, Naval Research Laboratory; H. Pomerance, F. D. McGowan, and H. Zeldes, Oak Ridge National Laboratory.

With this issue, Nuclear Science Abstracts begins a collaboration with the National Bureau of Standards Nuclear Data Group and its readers for the prompt and regular publication of summaries of new nuclear data. The tabular style adopted will make it possible for readers to find quickly new values for the properties of stable and radioactive nuclei and to incorporate these values into existing tables or compilations.

The plan is to have each issue of NSA carry a data summary for information published during a two-week period. It is hoped that eventually this two-week period will precede the NSA date of issue by not more than two months. Four times a year NSA will cumulate these summaries into large tables in which all new information reported in a three-month period will be arranged by element and isotope.

When the collaboration was decided upon last fall, the NBS group had on hand summaries of the data reported during September 1951. In order to get the plan into prompt operation, it was decided to start with this available material and carry a little more than two week's results for the first few issues until the time lag between publication of data and summarization has become as short as possible. It is hoped that the first cumulation in the issue of March 31, 1952, will cover all nuclear data made available between July 1, 1951, and approximately January 15, 1952. The third Supplement to "Nuclear Data," NBS Circular 499,\* which is now in press, will cover data reported between January 1, 1951, and July 1, 1951.

The plan used for the placing of different types of data is as follows: Information on  $\beta$  decay and the  $\gamma$  radiation accompanying it is given under the parent nucleus without cross reference to the daughter. Reaction energies (Q values) connecting ground states of nuclei are collected in a table at the end of the summary, together with doublet values and other mass information. Reaction data leading to level information about a product nucleus are reported under the product. Resonances are noted under the compound nucleus except in the case of neutron resonances which are listed under the target nucleus because of long-established custom.

It is not planned at present to include results on fission, spallation, or photo processes, charged-particle cross sections, or the very light particle reactions.

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\*NBS Circular 499 is available from the Government Printing Office. The price of \$4.25 includes the Circular and three Supplements which are sent to purchasers as they are issued.

## ABBREVIATIONS

a	absorption measurement	B	band spectra method
$a\beta\gamma$	absorption of $\beta$ 's in coincidence with $\gamma$ 's	$Be\gamma n$	measurement by detection of photoneutrons from Be
$ace^-$	absorption of conversion electrons	cc	cloud chamber
a coin	measurement by placing absorbers between counters in coincidence	$ce^-$	conversion electrons
$\alpha$	total $\gamma$ -ray conversion coefficient, $N_e/N_\gamma$	chem	chemical separation of product following reaction
$\alpha_K, \alpha_L, \dots$	$\gamma$ -ray conversion coefficient for electrons ejected from the K, L, ... shell	Cpt	Compton electrons
b	coefficient in angular correlation function, $1 + b \cos^2 \theta$	d	(1) deuteron, (2) descendant of, (3) days, when used as superscript

$D_{\gamma n}, D_{\gamma p}$	measurement by detection of photoneutrons or photoprotons from deuterium	q	electric quadrupole moment in units of barn:
$E_0$	resonance energy	Q	reaction energy in Mev
$E_\beta, E_\gamma, \dots$	energy of $\beta$ ray, energy of $\gamma$ ray, ...	s	(1) spectrometer method, (2) seconds, when used as superscript
$E1, E2, \dots$	electric dipole, electric quadrupole ...	S	atomic-spectra measurement
f	fission, in abbreviations for methods of production or detection	scin	scintillation counter
$\Gamma$	resonance half-width (the whole width at half-maximum)	sl	lens spectrometer
I	(1) spin in units of $\hbar/2\pi$ ; (2) nuclear induction magnetic resonance method	sl;ce <sup>-</sup>	conversion electrons measured in lens spectrometer
ic	ionization chamber	$s\pi$	180° spectrometer
K/L	$\alpha_K/\alpha_L$	$s\pi \sqrt{2}$	double focusing spectrometer
M	molecular or atomic beam resonance method	$\sigma$	cross section in barns
$M1, M2, \dots$	magnetic dipole, magnetic quadrupole ...	$\sigma_0$	cross section at resonance energy, $E_0$
mb	millibarns	$\sigma_a$	absorption cross section
Mic	microwave method	$\sigma_{el}$	elastic scattering cross section
ms	mass spectrometer	$\sigma_{in}$	inelastic scattering cross section
$\mu$	(1) magnetic moment in units of nuclear magnetons, (2) micron, $10^{-4}$ cm	$\sigma_s$	scattering cross section
$\mu s$	microseconds	$\sigma_t$	total cross section
osc	pile oscillator method	t	triton, $H^3$
para	paramagnetic resonance method	th	thermal
pc	proportional counter	$\tau$	half life in units indicated
pe <sup>-</sup>	photo electrons	$\beta\gamma, \gamma\gamma$	$\beta\gamma$ or $\gamma\gamma$ coincidences
ppl	photoplates or emulsions	$\beta\gamma(\theta)$	angular correlation of $\beta$ 's and $\gamma$ 's in coincidence
		d,p( $\theta$ )	angular distribution of protons with respect to deuteron beam

Standard journal abbreviations are used.

All energies are given in Mev and all cross sections in barns unless otherwise stated in the tabular material.

## NEW NUCLEAR DATA

$^1H_0^1$	$\mu$	$1.52101 \pm 0.00002$ $\times 10^{-3}(\text{eh}/4\pi mc)$	J. H. Gardner, <i>Phys. Rev.</i> <b>83</b> , 996(1951). Diamag. corr.	$^4Be_4^8$	Pair emitting level $\sim 7$ $B^{11}(7.9 \text{ p}, \alpha)$	G. C. Philips et al., <i>Phys. Rev.</i> <b>83</b> , 1049(1951).
$^1H_3^1$	No $\beta$ 's after $H^3(3.8 \text{ Mev } d)$ Yield $H^3(d, n)/He^3(d, p)$ $>1500$ $E_d = 0.5$ to $3.8$		K. G. McNeill and W. Rall, <i>Phys. Rev.</i> <b>83</b> , 1244(1951).		$\tau$ $< 5 \times 10^{-14}s$ $_{16}^{16}(\gamma, 4\alpha)$ stars	J. J. Wilkins and F. K. Goward, <i>Proc. Phys. Soc. (London)</i> <b>A64</b> , 849(1951).
$^3Li_4^7$	$Li^6(d, p\gamma)$ $p\gamma(\theta)$ consistent with $I = \frac{1}{2}$ for 0.480 level Level $Be^9(d, \alpha)$ 4.62		C. M. Class and S. S. Hanna, <i>Nature</i> <b>168</b> , 429(1951). R. W. Gelinas et al., <i>Phys. Rev.</i> <b>83</b> , 1260(1951).	$^4Be_6^{10}$	Level $Be^9(d, p)$ 3.34 ppl	A. J. Salmon, <i>Proc. Phys. Soc. (London)</i> <b>A64</b> , 848(1951).
$^3Li_5^8$	$\tau$ 0.825 <sup>s</sup> $Li(4 \text{ Mev } d, p)$ scin		W. Rall and K. G. McNeill, <i>Phys. Rev.</i> <b>83</b> , 1244(1951).	$^5B_7^{12}$	$\tau$ 0.027 <sup>s</sup>	J. E. Brolley, Jr., et al., <i>Phys. Rev.</i> <b>83</b> , 990(1951).
$^3Li_6^9$	$\tau$ 0.168 <sup>s</sup> Delayed n's		W. L. Gardner et al., <i>Phys. Rev.</i> <b>83</b> , 1054(1951). $Be(19 \text{ Mev } d, 2p)$ and $B, C, N(d \text{ and } p)$ .	$^6C_7^{13}$	Levels $C^{12}(d, p)$ 3.683 $\frac{1}{2}$ or $\frac{3}{2}, -$ 3.884 $\frac{3}{2}$ or $\frac{5}{2}, +$	J. Rotblat, <i>Phys. Rev.</i> <b>83</b> , 1271(1951) d,p( $\theta$ ); ppl. $E_d = 8$ .
				$^9F_9^{18}$	Levels $Ne^{20}(d, \alpha)$ 1.05 2.61 4.42 1.83 3.23 5.01 2.20 3.92 5.61 ppl	R. Middleton, C. T. Tai, <i>Proc. Phys. Soc. (London)</i> <b>A64</b> , 801(1951).



## NEW NUCLEAR DATA

$9\text{F}_{10}^{19}$	$\mu$	2.62807	I	T. Kanda et al., <u>Phys. Rev. 83, 1066(1951).</u>					
$9\text{F}_{11}^{20}$	Level	Ne $^{22}(\text{d},\alpha)$		R. Middleton, C. T. Tai, <u>Proc. Phys. Soc. (London) A64, 801(1951).</u>					
		0.57	ppl						
$10\text{Ne}_{11}^{21}$	Levels	Ne $^{20}(\text{d},\text{p})$		R. Middleton, C. T. Tai, <u>Proc. Phys. Soc. (London) A64, 801(1951).</u> *Isotopic assignment uncertain.					
		0.33 4.71 7.30							
		1.68 5.44 8.28							
		2.79 5.74 8.91							
		3.73 6.66*							
$10\text{Ne}_{13}^{23}$	Q's	Ne $^{22}(\text{d},\text{p})$		R. Middleton, C. T. Tai, <u>Proc. Phys. Soc. (London) A64, 801(1951).</u> *Isotopic assignment uncertain.					
		1.17, -0.04*							
$12\text{Mg}_{13}^{25}$	Mg $^{24}(\text{p}, 2\text{pn})\text{Na}^{22}$	$E_p \leq 92$		J. W. Meadows, R. B. Holt, <u>Phys. Rev. 83, 1257(1951).</u>					
	yield curve, $\sigma$								
$12\text{Mg}_{14}^{26}$	Mg $^{25}(\text{p}, 2\text{p } 2\text{n})\text{Na}^{22}$	$E_p \leq 92$		J. W. Meadows, R. B. Holt, <u>Phys. Rev. 83, 1257(1951).</u>					
	yield curve, $\sigma$								
$12\text{Mg}_{15}^{27}$	Mg $^{26}(\text{p}, 2\text{p } 3\text{n})\text{Na}$	$E_p \leq 92$		J. W. Meadows, R. B. Holt, <u>Phys. Rev. 83, 1257(1951).</u>					
	yield curve, $\sigma$								
$13\text{Al}_{15}^{28}$	Al(d,p)	$\gamma$ of 0.031		R. D. Smith, R. A. Anderson, <u>Nature 168, 429(1951).</u>					
		pc,a,scin							
	Al(p;p, $\alpha$ , $\gamma$ )	$E = 1.4-4$		F. C. Shoemaker et al., <u>Phys. Rev. 83, 1011(1951).</u>					
	yield curves								
$15\text{P}_{16}^{33}$	$\tau$	25 <sup>d</sup>		R. K. Sheline et al., <u>Phys. Rev. 83, 919(1951).</u>					
	$\beta^-$	0.26	a,sl	S,Cl( $\leq 48$ Mev $\gamma$ )					
	(0.5 Mev $\gamma$ )/ $\beta$	<0.07							
$17\text{Cl}_{19}^{36}$	I	2	Mic	C. M. Johnson, W. Gordy, <u>Phys. Rev. 83, 1249(1951).</u>					
	q	-0.0168	Mic						
$18\text{A}_{18}^{36}$	Cl $^{35}(\text{p},\gamma)$			K. J. Broström et al., <u>Phys. Rev. 83, 1265(1951).</u>					
	yield curve								
$18\text{A}_{20}^{38}$	Cl $^{37}(\text{p};\gamma,\text{n},\alpha)$			K. J. Broström et al., <u>Phys. Rev. 83, 1265(1951).</u>					
	yield curves								
$19\text{K}_{21}^{40}$	$\beta^-$	1.28	scin	M. L. Good, <u>Phys. Rev. 83, 1054(1951).</u>					
	$\Delta I = 4$ , yes shape								
	$\beta'$ s/sec(gm of K) = 27.1								
$27\text{Co}_{32}^{59}$	I	$\frac{1}{2}$	para	B. Bleaney, D. J. E. Ingram, <u>Proc. Roy. Soc. A208, 143(1951).</u>					
$27\text{Co}_{33}^{60}$	$\beta_1$	0.28% (1.56)							M. Deutsch, G. Scharff-Goldhaber, <u>Phys. Rev. 83, 1059(1951).</u>
	$\beta_3$	<10 <sup>-4</sup> % (2.9)							
$28\text{Ni}_{29}^{57}$	$\beta^+$	0.835	sl	R. Canada, A. C. G. Mitchell, <u>Phys. Rev. 83, 955(1951).</u> Fe( $\alpha,\text{n}$ ) chem. *Relative to annihil. $\gamma$ .					
	$\gamma$	0.123	ce <sup>-</sup> ,pe <sup>-</sup>						
		1.4*	pe <sup>-</sup>						
		0.2*	pe <sup>-</sup>						
$35\text{Br}_{52}^{87}$	$\beta^+$	0.336	st	R. Canada, A. C. G. Mitchell, <u>Phys. Rev. 83, 955(1951).</u> As( $\alpha, 2\text{n}$ ). *Relative intensities from pe <sup>-</sup> 's.					
	$\gamma$	0.64*	ce <sup>-</sup> ,pe <sup>-</sup>						
		20	ce <sup>-</sup> ,pe <sup>-</sup>						
		0.22	pe <sup>-</sup>						
		0.25	pe <sup>-</sup>						
		100	ce <sup>-</sup> ,pe <sup>-</sup>						
		8.6	pe <sup>-</sup>						
		25	pe <sup>-</sup>						
$37\text{Rb}_{49}^{86}$	I	2	M	E. H. Bellamy, <u>Nature 168, 556(1951).</u>					
	$\mu$	(-?)1.68	M						
$46\text{Pd}_{59}^{105}$	I	$\frac{5}{2}$	S	P. Brix, A. Steudel, <u>Naturwissenschaften 38, 431(1951).</u>					
	$\mu$	-0.6	S						
$53\text{I}_{69}^{122}$	$\tau$	3.6 <sup>m</sup>		J. N. Young et al., <u>Phys. Rev. 83, 1060(1951).</u> Te $^{122}$ (7.4 Mev p,n).					
	$\beta^+$	3.1	a						
$53\text{I}_{78}^{131}$	$\beta^-$	13.2% 0.334	sl	N. F. Verster et al., <u>Physica 17, 637 and 658(1951).</u> *Assigned value. See also Xe $^{131}$ .					
		86.2% 0.606							
		0.6% (0.807)*							
	$E_\gamma$	$\alpha_K$	K/L						
	0.080	0.7	7.0						
	0.284	0.039	K/L+M						
	0.364	0.019	4.2						
	0.636	0.0019							
	0.724								
$54\text{Xe}_{77}^{131}$	$\gamma$	0.163	sl,ce <sup>-</sup>	N. F. Verster et al., <u>Physica 17, 637(1951).</u>					
	$\sim 12^d$	K/L+M = 1.67							
$63\text{Eu}_{82}^{145}$	$\tau$	5 <sup>d</sup>		R. W. Hoff et al., <u>Phys. Rev. 83, 1068(1951).</u> Tb $^{149}$ $\alpha$ decay, Sm $^{147}$ (50 Mev p,3n) chem.					
	e <sup>-</sup>	0.2	a						
$63\text{Eu}_{83}^{146}$	$\tau$	38 <sup>h</sup>		R. W. Hoff et al., <u>Phys. Rev. 83, 1068(1951).</u> Sm $^{147}$ (19 Mev d,3n), Sm $^{144}$ (25 Mev $\alpha$ ).					
	e <sup>-</sup>	0.4	a						
$63\text{Eu}_{84}^{147}$	$\tau$	24 <sup>d</sup>		R. W. Hoff et al., <u>Phys. Rev. 83, 1068(1951).</u> Sm $^{147}$ (8.5 Mev p,n), chem.					
	e <sup>-</sup>	0.2	a						
	$\alpha$	2.88	ic						
	$\alpha/K \sim 10^{-5}$								
$63\text{Eu}_{85}^{148}$	$\tau$	50 <sup>d</sup>		R. W. Hoff et al., <u>Phys. Rev. 83, 1068(1951).</u> Sm $^{148}$ (8.5 Mev p,n).					
	e <sup>-</sup>	0.38	a						

$^{149}_{86}\text{Eu}$	$\tau$	$<1^h$ or $50^d$		R. W. Hoff et al., <u>Phys. Rev. 83, 1068(1951).</u> $\text{Sm}^{149}(8.5 \text{ Mev } p, n)$ .	$^{200}_{119}\text{Tl}$	$\gamma's$ (kev)	$s\pi, ce^-$	H. I. Isreal, R. G. Wilkinson, <u>Phys. Rev. 83, 1051(1951).</u> $\text{Au}(\alpha, n)$ , chem. No $\beta^+$ .	
						365 622 1,210			
						577 829 1,360			
$^{149}_{85}\text{Gd}$	$\tau$	$9^d$		R. W. Hoff et al., <u>Phys. Rev. 83, 1068(1951).</u>	$^{210}_{128}\text{Pb}$	$\gamma$	0.0467	sl	D. K. Butt, W. D. Brodie, <u>Proc. Phys. Soc. (London) 64, 791(1951).</u>
	$\alpha$	3.0	ic	$\text{Eu}(\sim 30 \text{ Mev } p, 3n)$ ,			$\alpha_L = 13.5$		
	$e^-$	0.35	a	$\text{Sm}^{147}(\sim 30 \text{ Mev } \alpha, 2n)$ , chem.			Bi Auger lines		
$^{185}_{109}\text{Os}$	K X-rays/L X-rays	= 1.5		M. M. Miller, R. G. Wilkinson, <u>Phys. Rev. 83, 1050(1951).</u>	$^{240}_{146}\text{Pu}$	$\tau$	$6580^y$		M. G. Inghram et al., <u>Phys. Rev. 83, 1250(1951).</u>
$^{189}_{113}\text{Os}$	I	$\frac{1}{2}$	S	S. Suwa, <u>Phys. Rev. 83, 1258(1951).</u>		$\tau$	$6240^y$		E. F. Westrum Jr., <u>Phys. Rev. 83, 1249(1951).</u>
	$\mu$	+0.6	S						
$^{203}_{123}\text{Hg}$	$\beta^-$	0.210	pc	H. W. Wilson, S. C. Curran, <u>Phil. Mag. 42, 762(1951).</u>	$^{242}_{148}\text{Pu}$	$\sigma(\text{th } n, \gamma)^{5h}\text{Pu}$	$\sim 100$		J. C. Sullivan et al., <u>Phys. Rev. 83, 1267(1951).</u>
	$\gamma$	0.278	$s\pi, pe^-$						
		$\alpha_K = 0.25$	K/L = 3.7						
$^{199}_{118}\text{Tl}$	$\gamma's$ (kev)		$s\pi, ce^-$	H. I. Isreal, R. G. Wilkinson, <u>Phys. Rev. 83, 1051(1951).</u> $\text{Au}(\alpha, 2n)$ , chem. No $\beta^+$ .	$^{243}_{149}\text{Pu}$	$\tau$	$5^h$		J. C. Sullivan et al., <u>Phys. Rev. 83, 1267(1951).</u>
		47 157 332				$\beta^-$	$\sim 0.5$	a	
		78 206 454							
		103 245 490							

## Q's Between Ground States

$\text{Be}^9(d, p)\text{Be}^{10}$	$4.55 \pm 0.03$ ppl	A. J. Salmon, <u>Proc. Phys. Soc. (London) 64, 848(1951).</u>
$\text{Ne}^{20}(d, p)\text{Ne}^{21}$	$4.54 \pm 0.04$ ppl	R. Middleton, C. T. Tai, <u>Proc. Phys. Soc. (London) 64, 801(1951).</u>
$\text{Ne}^{20}(d, \alpha)\text{F}^{18}$	$2.78 \pm 0.02$ ppl	R. Middleton, C. T. Tai, <u>Proc. Phys. Soc. (London) 64, 801(1951).</u>
$\text{Ne}^{22}(d, \alpha)\text{F}^{20}$	$2.62 \pm 0.10$ ppl	R. Middleton, C. T. Tai, <u>Proc. Phys. Soc. (London) 64, 801(1951).</u>









## AVAILABILITY OF AEC RESEARCH AND DEVELOPMENT REPORTS

The Reports Reference List (page iii) lists the declassified and unclassified research reports which are abstracted in this issue of Nuclear Science Abstracts.

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